



The Blast Furnace and Steel Plant

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The Blast Furnace *and* Steel Plant

The Steel Industries Future Problems

The Reconstruction Period Will Require Much Steel, but the Permanent Establishment of Foreign Trade Relations in the Steel Industry of the World Is of Paramount Importance.

The year 1918 will, without a question, go down in history secondary in importance only to the year 1914. Just exactly four years ago, we, in this country, realized that a war had started. We vaguely thought that some day it might effect this country. We thought we appreciated the economical changes that might occur, but not until 1917 did all these facts crystalize themselves in the American mind to the extent of producing action. When the enormity of the task before us was apparent and immediate production became vitally important, in fact so important that a lack thereof meant a penalty in human life, then, and then only, wonders were accomplished.

With far less warning than was given our entrance in the great conflict, the exit was announced. Over night we find ourselves considering after-war problems, transition from essential peace to essential war work, and then the establishing of normal conditions, the building of permanent, profitable industrial activity. Among the most important of these problems is the future foreign trade. The steel industry, probably more

than any other one industry, will be a great factor in our expansion. Not only will steel be required for reconstruction, but steel in the

form of finished equipment will be required to build up the industries of other countries, so that they in turn will reach a more or less independent state. And when this has been done keen competition for the undeveloped trade of the Far East will result. It is therefore of the greatest importance that we now study with all possible speed, the trade expansion possibilities of the steel industry. To further and promote this purpose. H. A. Andersen, publisher of THE BLAST FURNACE AND STEEL PLANT is starting on a tour of the world. The future policy of our columns will be to bring the steel industry of the world together as a unit.

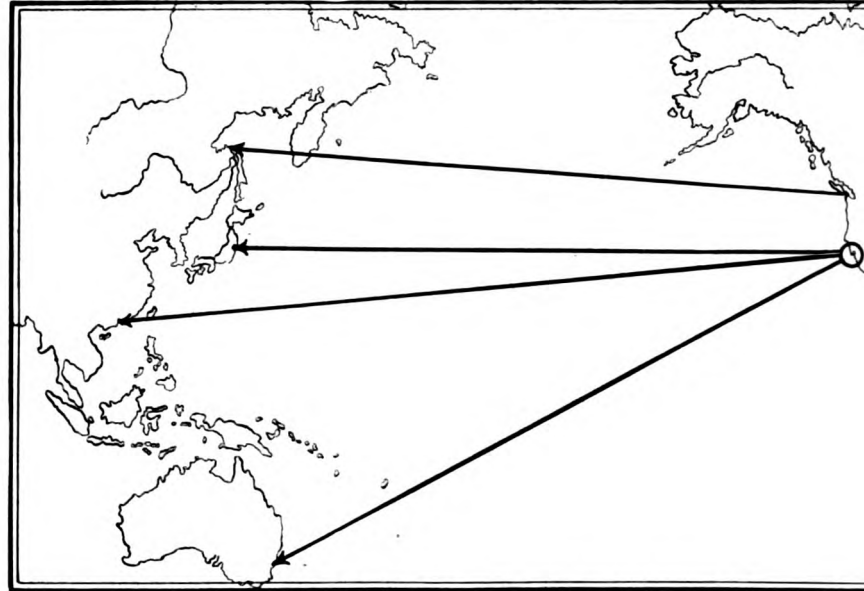
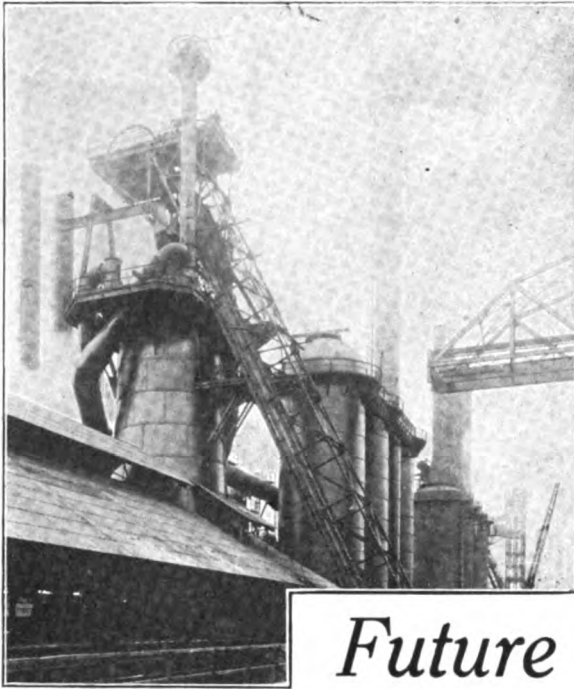
We shall publish technical and trade information concerning the foreign steel industries, in addition to our present contents. Thus a clear-

ing house" for the "steel industry of the world" will be established. Beginning with the February issue we will maintain a "Foreign Relations" department.



Great opportunities are present! Today we find our country at the end of the war, practically the only nation whose industries have not suffered by the ravishes of the great struggle. Particularly is this true of the steel industry. In view of these facts, coupled with our increased shipping tonnage we are placed in the most enviable position of not only being able to supply the immediate foreign demands, but also to lay the foundation for future permanent foreign trade.

—Underwood & Underwood.



Future American Influence in and Steel Industry —

An intelligent study of any problem is infinitely more valuable if based on actual statistics rather than on assumption or approximation. This article presents statistics on iron ore, coal, pig iron and steel, for the majority of the world's most important countries. Production, import and export data for 1913 and 1917 are shown. The figures for 1913 will show the prewar condition of the industry; those for 1917 give the latest available information.

A REVIEW of the reconstruction of the industries of war-torn Europe and the commercial reconstruction and prosperity of the rest of the world can almost be spelled in that magical word iron.

America, although late in realizing that her democracy was at stake in the world struggle, at last joined France, Belgium, Italy, Britain, and the other nations in the cause of national freedom and her predominant influence in war, together with her allies, soon placed the kultur of the Hun, who insisted that might was right, where it belonged, on the "Black List."

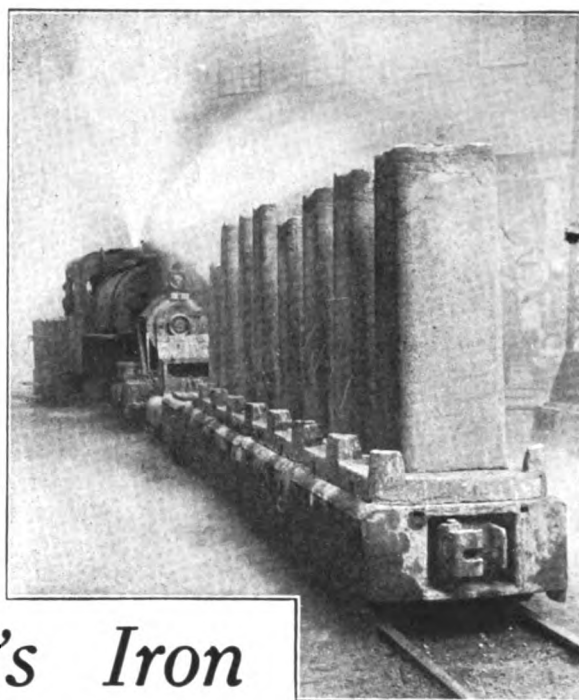
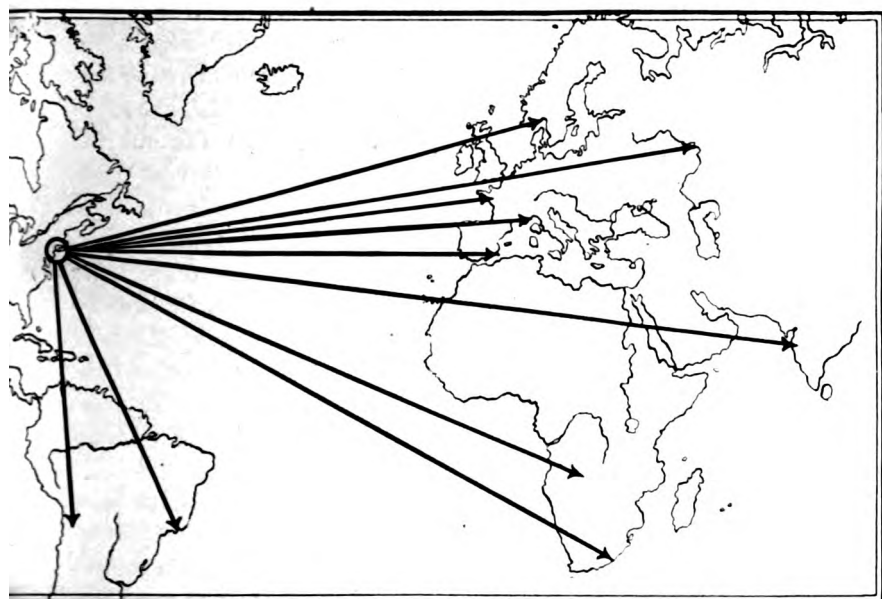
But what does all this signify as regards America's relationship to the regeneration of the world's iron and steel industry—this and this only, that without America's aid, Europe could not be reconstructed in a generation.

War, the destroyer under the rule of the Hun, has become a greater destroyer than ever. Wilfully, in

order to handicap her enemies in the race for reconstruction after the war, Germany has destroyed city and village, blast furnace and steel mill, mine and factory, machinery and plough, in fact everything that is necessary to maintain a nation's life and prosperity. Mr. Andre Tardieu, special commissioner to the United States, states that 70 per cent of the French steel mills were located in that portion of France held by Germany and that practically all the equipment has been either removed or destroyed.

Now, it is a matter of common knowledge, that without iron the reconstruction of all this devastation cannot take place. Mr. Tardieu estimates that nearly 4,000,000 tons of steel will be required for reconstruction. France and Belgium, with all their mines, furnaces, factories and machinery destroyed could not attempt the rehabilitation of their destroyed cities and villages, and the reconstruction of their industries under a generation without the assistance of American and British iron and steel.

In the interest of war, those industries in Europe which have not been actually destroyed by the Huns' ravishing hand, have been worked at such a pitch that many of them have been brought to a state where reconstruction or at least thorough overhaul and repair is necessary. In Britain and France, blast furnaces and rolling mills will require much replacement to bring them to their real efficiency. The engines, rolling stock, and equipment of the railways of these countries have been pressed to the utmost, with little or no repairs or replacements, as neither men nor materials could be spared to allow of their proper maintenance.



—Underwood & Underwood.

Regenerating the World's Iron Foreign Trade Data

So vital is transportation to a nation's commercial life that the railroads will have to receive immediate attention, and without sufficient iron and steel of their own, these countries, particularly Belgium and France, will have to look to America for their needs, until they are in a position, with American assistance, to develop their own resources.

Just as we had to do our part in the world war so we will have to do our part in the world's reconstruction and more particularly in the iron and steel industry for the reason that we are the greatest producers of iron and steel in the world. By force of circumstances we have been compelled to develop this industry to a degree little dreamt of by European manufacturers. The tables in the subsequent portion of this article, will show fully our relationship, in the iron and steel trade, to the rest of the world.

The only way in which America could compete with the cheap labor market of Europe, was to increase the efficiency of her high paid labor and by developing her mechanical resources to the maximum, the high cost of labor being counter-balanced by the high efficiency of mechanical methods both in mining and manufacture, so that in spite of labor cost, the American iron and steel industry is in a position to compete with the world.

A glance at the production efficiency table in this article will show that efficiency in tons per miner bears quite a striking relationship to the rate of wages drawn in the various countries.

In keeping with our mining efficiency has come our blast furnace and rolling mill supremacy, while in Europe the 100 and 150-ton blast furnace is above the

It has been estimated that 4,000,000 tons of steel will be required in the reconstruction of France alone. Who will supply this steel? To what extent will France increase her own steel industry? What are the possibilities for future Foreign trade, both in Europe and in the Far East? These are vital questions. This article, and several others in this issue, make an effort to throw some light on this and many other questions having a direct bearing on our future foreign trade relations.

average size, we have developed the 500-ton furnace. Necessity being the mother of invention we have been driven to a development of both our blast furnaces and rolling mills, so that today the American iron and steel industry stands head and shoulders above that of any other country in the world. Our technical experts head the world as is instanced by the fact that Australia, India, Italy and Japan, in the development of their iron resources, all had to come to America for both engineering knowledge and equipment.

Prior to the world war the coal, iron ore, pig iron and steel output of the principal countries of the world stood as shown in column 1 of tables No. 1, 2, 3, 4. America leading in pig iron and steel, with nearly 30 per cent greater production than Germany her nearest competitor, and Britain a bad third with a production of approximately only 33 1/3 per cent of America's total, although during 1917 most of the other nations had fallen away in production, the

Table I.
IRON ORE STATISTICS.

Reserve, Production, Import and Export Data for the Chief Nations of the World.

	Reserve in Mil- lion Tons	PRODUCTION.		IMPORT		EXPORT	
		1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons
United States..	4257	61980	76493	2279	1175	1233	1139
England	1300	16263	13494 ¹	7766	7017 ¹	5	0.6
Canada ... unknown		307	355	2116	2318	123	155
Germany	1374	7461 ²	3500 ³	14024	5000 ⁴	2613	none
Alsace-Lorraine	2330	21136	10000 ⁵				
France	3300	21714	10000 ⁵	1400 ⁶	627 ⁷	8000 ⁸	
Italy	6	603	700 ⁹	8	1 ⁹		
Sweden	1158	7476	6986 ¹	3	102	439 ⁹	5702
Norway	367	544	800			568	456 ¹¹
Spain	711	9861	6000 ¹²			2384 ¹³	2371 ¹
Russia	864 ¹⁴			27		663 ¹⁵	
India	500	370	418 ¹	20 ¹⁴	21 ¹		
China	700	468	600		10 ¹⁵	273	350 ¹⁶
Japan	55	214	300 ¹⁸	280	282 ¹		
Africa	125	200 ¹⁵	250 ¹⁵			120 ¹⁵	
S. America.....	9000	170 ¹⁵	220 ¹⁵			130 ¹⁵	
Australia	135	164	205 ¹⁵				
Portugal	75	49	6 ¹¹				
Belgium	62	150	80 ¹⁵	7084		78	

¹ 1916; ² 270 Luxemburg; ³ estimate; ⁴ estimate; ⁵ estimate; ⁶ pre-war average; ⁷ 1916; ⁸ estimate; ⁹ 1916; ¹⁰ estimate; ¹¹ 1914; ¹² estimate; ¹³ 1914; ¹⁴ European; ¹⁵ 1912; ¹⁶ prewar average; ¹⁷ estimate; ¹⁸ estimate.

United States had increased her output nearly 33 1/3 per cent. Britain being the only warring European nation able to maintain her prewar production. Thus with the coming of peace America stands in a position to supply a large portion of the urgent requirement of war stricken Europe and the war restricted

East.

In spite of the fact that our own ship-building program may slacken off, the fact remains that the world is still short of ships, it being estimated that the marine carrying tonnage of all nations is 19,000,000 tons short of what it would have been by this date had not war and the Hun submarines intervened, and it is only reasonable to expect that European nations will develop their shipbuilding to a large extent to make up this deficiency, and that at least orders for a portion of the steel necessary for constructing same will fall to the American manufacturers.

In order that one may not be challenged with the fact that before the war America could not compete with the European manufacturers (and we have before us an instance of Germany, in spite of the long shipping distance, was supplying steel to the Pacific coast just prior to the war, at a cheaper rate than it could be purchased of the home manufacturers) we would point out that conditions in Europe have changed, especially labor conditions, and are likely to remained changed, owing to the depletion of her manpower. Although European labor rates have not reached those of America, they have advanced considerably, and, owing to the growth of labor unions, both higher wages and shorter hours than existed prior to the war are likely to be the order of the day.

This, combined with their smaller plants, is sure to increase costs, so that America will now be on an equal, if not a better footing.

Britain will be a producer and will no doubt increase her production, but never again at prewar prices.

Even if Germany could supply the goods it is doubtful if her late enemies would deal with her for many years to come. Also, consideration must be given to the fact that it is not likely that the new socialistic government of Germany will give the assistance to her manufacturers that the kaiser's did.

Another fact that must not be overlooked is that Germany, even before the war, with Alsace-Lorraine in her possession, did not produce enough ore or pig to meet the requirements of her own mills. With the restoration of Alsace-Lorraine to France, Germany will be ruled out as a competitor, at least until such time as France has restored her old ore fields and brought those of her returned provinces to a state that will not only meet her own

Table II.
COAL STATISTICS.

Reserve, Production, Import and Export Data for the Chief Nations of the World.

	Reserve in Mil- lion Tons	PRODUCTION.		IMPORT		EXPORT	
		1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons
United States	3838657	541562	650981	1601	1301	20969	24529
England	189533	292040	252000	24	4	74623	38203
Canada	1234769	13622	12714	13878	15874	1920	1700
Germany	423356	191511	150000 ¹	18268		44253	
Als'e-Lor'e. }							
France	17583	40843	28930	19779	17333	2000 ²	
Italy	243	701	1200 ³	10835	8065	192	94 ⁴
Sweden	8864	364	414 ⁵	5374	3000 ¹	0.6	
Norway				2482	2749 ⁶		
Spain	8768	4293	5973 ¹	3500 ⁷	2000 ⁸		
Russia	233000	33736	26274 ⁹	8807			
India	7900	16464	16416 ³	5100			
China	995587	16534 ³	24000 ¹	1690	1444 ⁴	1489	1937
Japan	7920	21315	25660	576	551 ⁵	3870	2443 ⁶
Africa	57839	9300 ¹	13000 ¹				
S. America	32097	500 ¹	500 ¹	580 ¹	300 ¹		
Australia	170410	14528	6000 ¹	4	6 ³	2132	944
Portugal	20	25	32 ⁴				
Belgium	11000	22846	18000 ¹	8874		4944	

¹ Estimate; ² pre-war average; ³ 1916; ⁴ 1914; ⁵ 1912; ⁶ estimate 50 per cent of pre-war average.

requirements but those of her recent Allies—Belgium and Italy. Then and then only is she likely to sell surplus ore to Germany.

A little review of Germany's prewar and present position in the production of iron ore, and consequently machinery made from iron, and more particularly blast furnace and rolling mill equipment, will show the correctness of the above contention. In 1913 Germany's consumption of iron ore was approximately 30,000,000 tons of which 21,000,000 was produced from the returned French provinces of Alsace-Lorraine, 7,500,000 from Germany proper, and the balance imported from Spain, Sweden, etc.

Examination of recent statistics shows that in 1917, Germany's own field only produced some 3,500,000 tons, and the Alsace-Lorraine field 10,000,000. It is probable that the Alsace-Lorraine fields, now in the possession of France, are not in a position, without considerable reconstruction and development, to more than meet the domestic demands of France and Belgium.

The German fields have also suffered to the extent of a deficiency of 50 per cent in production, owing to war, shortage of labor, and want of maintenance. So it is reasonable to expect that Germany, with only a possible supply of at best 10,000,000 tons of ore per annum, will not be in a position to compete with America in the supply of either manufactured iron, steel or machinery. In addition to this Germany, by the armistice terms, has been called upon to deliver to the Allies, 5,000 locomotives, 150,000 railway wagons, and there is no reason to believe that these will be returned to her under the peace terms, but rather it may be expected that they will be retained by the Allies to replace the rolling stocks of Belgium, France, Italy and Serbia, destroyed by the Central Powers during the war. These items in which iron and steel is the dominant factor, will have to be replaced by Germany before she can turn her industries to outside trade.

A thorough search of all the latest literature and statistics, as well as conversations with the leaders in the following industries, coal, iron ore, iron and steel has enabled us to compile tables No. 1, 2, 3 and 4, which cannot be received by the American industrial captains and labor, without a just feeling of pride. A review of these tables will make evident that we are practically the only nation (with an iron production of any size) that war has not either devastated

Table III.
PIG IRON STATISTICS.

Production, Import and Export Data for the Chief Nations of the World.

	PRODUCTION.		IMPORT		EXPORT	
	1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons
United States.....	30966	39269	159	117	291	847
England	10481	9420	220	160	1186	743
Canada	1015	1063	303	69	6	23
Germany	19291	11000 ¹	124	200	782	.....
Alsace-Lorraine	4000 ²	1000 ²	.....	.....	.....	.....
France	5227	3000 ¹	49	621 ³	200 ⁴	.....
Italy	420	454 ⁵	221	302 ⁵	.....	.....
Sweden	730	837	172 ⁵	166 ⁵	208	495
Norway	0.3	10 ¹	30	32 ⁵	26	14 ⁶
Spain	418	500	.....	.....	.....	46 ⁶
Russia	4474	3786 ⁵	108	.....	see steel	.....
India	150	250 ⁵	450 ⁷	326 ⁷	503 ⁷	72 ⁸
China	200 ¹	500 ¹	7	12	71	170
Japan	350 ⁹	510 ⁹	265	232 ⁹	small	small
Africa	20 ¹	30 ¹	.....	.....	.....	.....
S. America.....	25 ¹	35 ¹	.....	.....	.....	.....
Australia.....	90	102	76 ¹⁰	31 ¹¹	see st'l	see st'l
Portugal .....	.....	.....	.....	.....	.....	.....
Belgium	2484	2200 ¹	578	.....	16	.....

¹ Estimate; ² Lorraine only; ³ 1916; ⁴ pre-war average; ⁵ includes scrap; ⁶ 1914; ⁷ pre-war average; ⁸ iron and steel, 1916; ⁹ estimate includes pig iron manufactured from imported iron; ¹⁰ includes scrap; ¹¹ includes scrap, 1916.

or else under the strenuous conditions and neglect of war, been brought to a state of inefficiency. Japan is the only notable exception to this. America had a production of nearly 43,500,000 tons of steel in 1916 and slightly less in 1917, and about the same as in 1917.

Table IV.
STEEL STATISTICS.

Production, Import and Export Data for the Chief Nations of the World.

	PRODUCTION.		IMPORT		EXPORT	
	1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons
United States.....	31822	43486 ¹	21	28	543 ¹	2883 ¹
England	7787	9909	518 ²	123	553	682
Canada	1060	1557	.....	.....	.....	.....
Germany	18958	11000 ³	.....	.....	.....	.....
Alsace-Lorraine .....	.....	.....	.....	.....	.....	.....
France	4419	2000 ¹	567 ⁵	1659 ⁵	150 ⁴	.....
Italy	911	1200 ⁴	326	380 ⁴	.....	.....
Sweden	582	800 ⁴	.....	.....	.....	.....
Norway .....	.....	.....	3	2 ⁷	0.1	1 ⁷
Spain	365	400 ⁴	.....	.....	.....	27
Russia	4039	3362 ⁵	19 ⁸	.....	.....	.....
India	75	114 ⁷	120 ⁸	74 ⁷	50 ¹⁰	72 ²
China	100 ⁴	200 ⁴	60	31	.....	.....
Japan	320	570	.....	.....	.....	.....
Africa	15 ⁴	20 ⁴	.....	.....	.....	.....
S. America.....	15 ⁴	20 ⁴	.....	.....	.....	.....
Australia.....	110	129	253 ¹¹	81 ¹²	9 ¹³	0.9 ¹⁴
Belgium	2510	1000 ⁴	1008	.....	1728	.....

¹ Billets, ingots and blooms, bars and rods; ² 1916; ³ steel ingots; ⁴ estimate; ⁵ blooms, billets and bars; ⁶ pre-war average estimate; ⁷ 1914; ⁸ steel and iron, 1912; ⁹ prewar average; ¹⁰ iron and steel; ¹¹ bars, rods, etc.; ¹² bars, rods, 1916; ¹³ iron and steel; ¹⁴ iron and steel, 1916.

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Table II.
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Reserve, Production, Import and Export Data for the Chief Nations of the World.

	Reserve in Mil- lion Tons	PRODUCTION.		IMPORT		EXPORT	
		1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons	1913 in Thou- sand Tons	1917 in Thou- sand Tons
United States	3838657	541562	650981	1601	1301	20969	24529
England	189533	292040	252000	24	4	74623	38203
Canada	1234769	13622	12714	13878	15874	1920	1700
Germany	423356	191511	150000 ¹	18268	.....	44253	.....
Als'e-Lor'e. }	.....	.....	.....	.....	.....	.....	.....
France	17583	40843	28030	19779	17333	2000 ²	.....
Italy	243	701	1200 ³	10835	8065	192	94 ⁴
Sweden	8864	364	414 ⁵	5374	3000 ¹	0.6	.....
Norway .....	.....	.....	.....	2482	2749 ⁶	.....	.....
Spain	8768	4293	5973 ⁷	3500 ⁷	2000 ⁷	.....	.....
Russia	233000	33736	26274 ⁸	8807	.....	.....	.....
India	7900	16464	16416 ⁸	5100	.....	.....	.....
China	995587	16534 ⁹	24000 ¹	1690	1444 ⁴	1489	1937
Japan	7920	21315	25660	576	551 ³	3870	2443 ³
Africa	57839	9300 ¹	13000 ¹	.....	.....	.....	.....
S.America	32097	500 ¹	500 ¹	580 ¹	300 ¹	.....	.....
Australia	170410	14528	6000 ¹	4	6 ³	2132	944
Portugal	20	25	32 ⁴	.....	.....	.....	.....
Belgium	11000	22846	18000 ¹	8874	.....	4944	.....

¹ Estimate; ² pre-war average; ³ 1916; ⁴ 1914; ⁵ 1912; ⁶ estimate 50 per cent of pre-war average.

requirements but those of her recent Allies —Belgium and Italy. Then and then only is she likely to sell surplus ore to Germany.

A little review of Germany's prewar and present position in the production of iron ore, and consequently machinery made from iron, and more particularly blast furnace and rolling mill equipment, will show the correctness of the above contention. In 1913 Germany's consumption of iron ore was approximately 30,000,000 tons of which 21,000,000 was produced from the returned French provinces of Alsace-Lorraine, 7,500,000 from Germany proper, and the balance imported from Spain, Sweden, etc.

Examination of recent statistics shows that in 1917, Germany's own field only produced some 3,500,000 tons, and the Alsace-Lorraine field 10,000,000. It is probable that the Alsace-Lorraine fields, now in the possession of France, are not in a position, without considerable reconstruction and development, to more than meet the domestic demands of France and Belgium.

The German fields have also suffered to the extent of a deficiency of 50 per cent in production, owing to war, shortage of labor, and want of maintenance. So it is reasonable to expect that Germany, with only a possible supply of at best 10,000,000 tons of ore per annum, will not be in a position to compete with America in the supply of either manufactured iron, steel or machinery. In addition to this Germany, by the armistice terms, has been called upon to deliver to the Allies, 5,000 locomotives, 150,000 railway wagons, and there is no reason to believe that these will be returned to her under the peace terms, but rather it may be expected that they will be retained by the Allies to replace the rolling stocks of Belgium, France, Italy and Serbia, destroyed by the Central Powers during the war. These items in which iron and steel is the dominant factor, will have to be replaced by Germany before she can turn her industries to outside trade.

A thorough search of all the latest literature and statistics, as well as conversations with the leaders in the following industries, coal, iron ore, iron and steel has enabled us to compile tables No. 1, 2, 3 and 4, which cannot be received by the American industrial captains and labor, without a just feeling of pride. A review of these tables will make evident that we are practically the only nation (with an iron production of any size) that war has not either devastated

Table III.
PIG IRON STATISTICS.
Production, Import and Export Data for the Chief Nations of the World.

	PRODUCTION.		IMPORT		EXPORT	
	1913	1917	1913	1917	1913	1917
	in	in	in	in	in	in
	Thou-	Thou-	Thou-	Thou-	Thou-	Thou-
	sand	sand	sand	sand	sand	sand
	Tons	Tons	Tons	Tons	Tons	Tons
United States.....	30966	39269	159	117	291	847
England	10481	9420	220	160	1186	743
Canada	1015	1063	303	69	6	23
Germany	19291	11000 ²	124	200	782	.....
Alsace-Lorraine	4000 ²	1000 ²	.....	.....	.....	.....
France	5227	3000 ²	49	621 ²	200 ²	.....
Italy	420	454 ²	221	302 ²	.....	.....
Sweden	730	837	172 ²	166 ²	208	495
Norway	0.3	10 ¹	30	32 ²	26	14 ²
Spain	418	500	.....	.....	.....	46 ²
Russia	4474	3786 ²	108	.....	see steel	.....
India	150	250 ²	450 ²	326 ²	503 ²	72 ²
China	200 ¹	500 ¹	7	12	71	170
Japan	350 ²	510 ²	265	232 ²	small	small
Africa	20 ¹	30 ¹	.....	.....	.....	.....
S. America.....	25 ¹	35 ¹	.....	.....	.....	.....
Australia.....	90	102	76 ¹⁰	31 ¹¹	see st ¹	see st ¹
Portugal .....	.....	.....	.....	.....	.....	.....
Belgium	2484	2200 ¹	578	.....	16	.....

¹ Estimate; ² Lorraine only; ³ 1916; ⁴ pre-war average; ⁵ includes scrap; ⁶ 1914; ⁷ pre-war average; ⁸ iron and steel, 1916; ⁹ estimate includes pig iron manufactured from imported iron; ¹⁰ includes scrap; ¹¹ includes scrap, 1916.

or else under the strenuous conditions and neglect of war, been brought to a state of inefficiency. Japan is the only notable exception to this. America had a production of nearly 43,500,000 tons of steel in 1916 and slightly less in 1917, and about the same as in 1917.

Table IV.
STEEL STATISTICS.
Production, Import and Export Data for the Chief Nations of the World.

	PRODUCTION.		IMPORT		EXPORT	
	1913	1917	1913	1917	1913	1917
	in	in	in	in	in	in
	Thou-	Thou-	Thou-	Thou-	Thou-	Thou-
	sand	sand	sand	sand	sand	sand
	Tons	Tons	Tons	Tons	Tons	Tons
United States.....	31822	43486 ²	21	28	543 ¹	2883 ¹
England	7787	9909	518 ²	123	553	682
Canada	1060	1557	.....	.....	.....	.....
Germany	18958	11000 ²	.....	.....	.....	.....
Alsace-Lorraine .....	.....	.....	.....	.....	.....	.....
France	4419	2000 ¹	567 ²	1659 ²	150 ²	.....
Italy	911	1200 ²	326	380 ²	.....	.....
Sweden	582	800 ²	.....	.....	.....	.....
Norway .....	.....	.....	3	2 ¹	0.1	1 ¹
Spain	365	400 ²	.....	.....	.....	27
Russia	4039	3362 ²	19 ²	.....	.....	.....
India	75	114 ²	120 ²	74 ²	50 ¹⁰	72 ²
China	100 ²	200 ²	60	31	.....	.....
Japan	320	570	.....	.....	.....	.....
Africa	15 ²	20 ²	.....	.....	.....	.....
S. America.....	15 ²	20 ²	.....	.....	.....	.....
Australia.....	110	129	253 ¹¹	81 ¹²	9 ¹³	0.9 ¹⁴
Belgium	2510	1000 ²	1008	.....	1728	.....

¹ Billets, ingots and blooms, bars and rods; ² 1916; ³ steel ingots; ⁴ estimate; ⁵ blooms, billets and bars; ⁶ pre-war average estimate; ⁷ 1914; ⁸ steel and iron, 1912; ⁹ prewar average; ¹⁰ iron and steel; ¹¹ bars, rods, etc.; ¹² bars, rods, 1916; ¹³ iron and steel; ¹⁴ iron and steel, 1916.

Of the four leading iron and steel producing countries of the world only the United States has been able to add materially to its prewar output both with reference to steel and iron. Germany and France have lost nearly 50 per cent of their former productive efficiency and England has just been able to hold its own. As a result there has taken place a general decline in the world's production of iron and steel which is still more aggravated by the fact that during the same time great quantities of the floating supply of old iron have been lost. A much larger use has been made of scrap iron for resmelting than is the case in normal years. Also much iron doubtless has been lost by actual fighting, exposure to the climate, and from other causes.

Production of Iron Ore.

Lack of labor has been principally responsible for the great reduction in the production of iron ore. A great number of the mines of continental Europe, those especially in France, have not been worked at all and the remaining with a labor force approximately 50 per cent below their normal strength. In Germany proper the production of iron ore had been 7,561,000 tons in 1913. It is estimated to be today only 3,500,000. Much of the iron production of Germany is derived from Alsace-Lorraine. Alsace-Lorraine had produced 21,136,000 tons of iron in 1913; it is estimated to have produced only 10,000,000 tons during the year 1917, bringing the total German production of iron ore to approximately 13,500,000 tons, which figure also includes the production of Luxemburg. The French ore production which was 21,714,000 tons during the year 1913, is estimated to be today 10,000,000 tons, most of which has been mined by the Germans who have kept going as many of the French mines in the occupied territory as they could. The Belgium production of iron ore declined approximately 150,000 tons in 1913 to 80,000 tons during 1917. Also the English ore production has suffered heavily. It was 16,263,000 in 1913 and only 13,494,000 tons during 1916, which is the latest figure so far obtainable. Statistical information as to the situation in the other iron producing countries of Europe is not always available. Many of these nations have abstained from publishing their national statistics; others have held back with the information for political reasons. Nevertheless it has been possible to obtain, by searching through technical journals and similar publications, a fairly exact impression of the size and character of the iron ore production in these fields. Italy which has produced 603,000 tons of iron ore during the year 1913 apparently has been able to increase its production slightly, and it is estimated today to be 700,000 tons. Sweden, which has suffered a good deal by labor difficulties, has not been able to keep up its prewar production of 7,476,000 tons, and a production of only 6,986,000 is recorded for the year

1916. Norway, on the other hand, seems to have increased its production from 544,000 tons to 800,000 tons during the year 1917. If the most recent estimates are correct there have taken place considerable reductions in the iron ore production on the Pyrenean peninsula. Spain having produced 9,861,000 tons during 1913 is now estimated with a production of 6,000,000 tons only in 1917, and the small production of iron ore coming from Portugal, 49,000 tons in prewar times, has practically been wiped out. No figures referring to the production of iron ore can be obtained from Russia.

Turning to the United States of America, an increase in the iron ore production can be recorded from 61,980,000 tons in 1913 to 76,493,000 tons in 1917. Canada has raised its annual production from 307,000 tons to 355,000 tons. Conditions are somewhat unclear as to South America. At the best only estimates can be obtained. These put the iron ore production in 1913 at 170,000. Increases in production are reported from Brazil and Chile, so that the South American total production can be very well estimated at 220,000 tons for the year 1917. The African production is now estimated at 250,000 tons, while that of Australia has been estimated at 205,000 tons, notwithstanding extensive labor difficulties in that part of the world.

France, England, and Germany, have supplemented in prewar times, their own iron ore resources by importing iron ore in large quantities. Germany has been the largest importer, drawing iron not only from her immediate neighbors but from practically all over the world. Fourteen million tons of iron ore have been imported in this way into Germany during each year before the war. Since the outbreak of the war Germany has not been able to import much iron ore, but the total imports nevertheless have been estimated at 5,000,000 tons during the year 1917. Most of the ore is said to have come from Austria-Hungary and also from Sweden. France has imported only 627,000 tons in 1916, against its prewar average of 1,400,000 tons, while the imports of iron ore into England have remained practically stationery, at least as far as can be seen from the published statistics. Japan has received more iron ore from China than in prewar times, but part of this iron seems to have gone into Korea where Japanese smelters are now busy turning it into pig iron. Owing to the increased demand for iron ore there has been all through the war a tendency among the large iron producing countries to retain more of the ore at home than in normal times. Sweden for instance, which exported during the year 1913, 6,439,000 tons of iron ore, has exported 5,702,000 tons only during 1916.

Pig Iron.

The same causes which have acted on the production of iron ore also have exerted their influence on

the production of pig iron. During the year 1917, 30,269,000 metric tons of pig iron were produced in the United States against 30,966,000 tons in the year 1913. This is the only material progress made in the production of pig iron in any country.

Table V. RELATIVE IRON ORE AND PIG IRON EXPORTS. In Thousand Dollars, 1913.					
England to		U. S. A. to		Germany to	
Sweden	\$ 1620	Austria-Hung'y.	\$ 116	Belgium	\$4753
Germany	2195	Italy	296	Denmark	110
Netherlands ..	1310	England	361	France	2119
Belgium	1875	Canada	3124	England	920
France	3115			Italy	1108
Italy	1900			Netherlands ..	860
Japan	1725			Austria-Hung'y.	1882
U. S. A.	5415			Sweden	146
Brit. E. Indies.	345			Switzerland	818
Australia	500				
Canada	3025				

IMPORT OF IRON ORE In Thousand Dollars, 1913.					
Into England From		Into U. S. A. from		Into Germany from	
Russia	\$ 445	Spain	\$ 439	Belgium	\$ 318
Sweden	1940	Sweden	1461	France	6192
Norway	2535	Canada	282	Greece	625
Netherlands ..	105	Newfoundland ..	238	Norway	1858
Belgium	1325	Cuba	4408	Austria-Hungary..	490
France	3535	Venezuela	139	Portugal	155
Spain	21565			Russia	3181
Greece	860			Sweden	21687
Tunis	4370			Spain	18160
Canada	420			Algeria	2501
				Tunis	716
				British India	172

The production of pig iron in England fell from 10,481,000 tons to 9,420,000 tons, while that of Germany, France, Belgium, and Luxemburg, declined at the rate of at least 50 per cent, taking the whole industrial district of Northwestern Europe as a whole. Italy, severely pressed for pig iron, has made great efforts to raise the national production with very limited results only, the production being 454,000 tons in 1916, against 420,000 tons in 1913. Sweden and Norway on the other hand, have been more successful. The erection of a number of new blast furnaces in these countries has increased the production of pig iron in Sweden from 730,000 tons to 837,000 and considerable increases have also taken place in Norway. Spain has increased its pig iron output from 418,000 tons to an estimated 500,000 tons, while the Russian output shows a considerable decrease, being 3,786,000 tons in 1917, against 4,474,000 in 1913. India has been able to add 100,000 tons to its prewar production, while the Chinese output of pig iron is now estimated at more than double its prewar size. The Japanese production has grown from 350,000 tons to 510,000 much of which, however, is won from imported ore. The Australian production is probably somewhat higher than it was before the war.

France has been able to make up its enforced shortage of pig iron by an increased import which has

come largely from the United States. Also Germany is generally said to have imported about 200,000 tons of pig iron during the year 1917. Italy has increased its imports from 221,000 tons in 1913 to 302,000 tons in 1916, the last figure obtainable. Among the prewar exporters of pig iron only the United States have added materially to their exports by nearly trebling these against prewar times. England reduced its exports from 1,186,000 tons to 743,000 tons while no iron apparently was exported from Germany. Sweden seems to have increased its exports and also China has exported more pig iron than in prewar times.

Steel.

By far the largest producer of steel in the world is now the United States. During the year 1916 the last for which official figures can be obtained the production of steel amounted to 43,486,000 tons which is an enormous increase against the year 1913, when only 31,822,000 tons were produced. The extent of this growth of the American industry may be best understood if one contemplates that the whole steel production of England amounted to 9,909,000 tons only, during the year 1917. It had been 7,787,000 tons during the year 1913. Canada has been very successful in increasing the output of its steel industry from 1,060,000 tons in 1913, to 1,557,000 tons in the year 1917. Naturally there has been a considerable decrease in the production of the European continental industry especially that part in which actual fighting has gone on. The German steel production including that of Alsace-Lorraine and Luxemburg has declined from 18,958,000 tons to an estimated 11,000,000 tons which is most likely still a very high estimate. The French output of steel now

Table VI. COMPARATIVE PRODUCTION EFFICIENCY.			
Production of coal per head of miner per year.		Production of iron ore per head of miner per year.	
	Tons		Tons
U. S. A.	671	U. S. A.	14021
England	248	Germany	6653
Germany	276	Sweden	6040
France	208	Russia	1579
Belgium	158	Italy	2111
Russia	148	Spain	2592
Spain	158		
Australia	549		
India	113		
Japan	121		

is estimated at 2,000,000 tons against 4,419,000 in the year 1913, while that of Belgium may be 1,000,000 tons against 2,510,000 tons in 1913. Italy, by importing iron ore and pig iron and by raising its own production of ore and iron has been able to add materially

Export Men Answer the Question of

IN the future development of the blast furnaces and rolling mills of France, what are the opportunities for American manufacturers receiving orders for this equipment?

The opportunities for American manufacturers receiving orders for equipment for blast furnaces and rolling mills in France should be very good, provided equipment is offered at a satisfactory price and liberal credit terms are arranged. According to a statement recently made by Andre Tardieu, who is one of the commissioners representing the French government in this country, 70 per cent of the steel mills of France were located in the districts occupied by the Germans. It is Mr. Tardieu's belief that all equipment of any value has been either carried away or destroyed.

C. D. SNOW, Assistant Chief of Bureau of Foreign and Domestic Commerce.
Very few opportunities present themselves to American manufacturers to supply equipment for the blast furnaces and rolling mills of France.

C. GREEN, Federal Export Company.
It appears to us that the opportunities for American manufacturers receiving orders for blast furnaces and rolling mill equipment in general for France and Belgium are very good, if they go about it in the right manner.

G. A. HARRIS, Chief Engineer, American Steel Export Co.

The opportunities will be good for a year or two, after which Europe will have sufficiently recuperated to supply her own requirements.

A. M. GARBADE, Pacific Commercial Co.
I spent four months in France last winter on this particular subject and it is my personal opinion that for a comparatively short period—say a year or two—there will be a very considerable demand for American blast furnace and rolling mill equipment. This is due, principally, to the fact that it will be some little time before England, Belgium or France can supply their needs in this respect. It will be essential, however, that these articles conform in some degree to French standards and this matter of co-ordinating the French and American practice will be one of the difficult matters to arrange. The Frenchmen may come over here and buy a rolling mill or a particular machine according to American plans, but I believe that practically all the blast furnaces will have to be of partly American and partly French design. I believe this will apply to a great many of the other features of steel plant construction.

MORRIS METCALF, Vice President American International Steel Corporation.

Before the war Germany supplied a great deal of equipment for French blast furnaces and rolling mills, but if anything is certain it is that Germany for at least a generation to come will be entirely eliminated as far as French trade is concerned. Great opportunities are, therefore, created for American manufacturers of steel products, and much of the special equipment needed in the restoration of the French iron mines, blast furnaces and steel works will be furnished by the United States.

VICTOR E. KARMINSKI, Secy. and Gen. Mgr. Rowson, Drew & Clydesdale, Inc.

WHAT methods would you advise American manufacturers using to get in touch with these requirements?

American manufacturers should preferably have their representatives on the ground in order to keep in close touch with the technical requirements of the French mills. It might also be advisable for them to form a co-operative export selling agency, under the provision of the Webb Act, allowing combinations for foreign trade. The administration of this act is vested in the Federal Trade Commission which will be glad to give detailed advice regarding methods of procedure in organization.

C. D. SNOW.
The best best means by which American manufacturers can get in touch with requirements of these mills is to send capable representatives to France, and judgment should be used in selecting men who have a very

RESULTS OF QUESTIONNAIRE ADDRESSED AND STEEL PLANT INDICATES FOR SOME EXCELLENT OPPORTUNITIES FOR IRON, IN THE PRODUCTION OF IRON AND STEEL--

broad and thorough knowledge of their field and, as well, a keen appreciation of the French temperament.

C. GREEN.

American manufacturers must prepare for a revolutionary change in French methods of purchasing. Instead of selling to thousands of individual buyers, the American manufacturer will have to deal with a small number of central purchasing agencies representing groups of French manufacturers engaged in the same or related industries and assisted by the credit of the French government. With special reference to the steel machinery industry would state that the French steel men believe that one of the best ways for America to help them is by placing at their disposal as soon as the war ends some tried form of co-operative selling. The French steel makers do not wish to be obliged to obtain prices from several hundred American firms engaged in the business of supplying the thousands of articles needed in the construction of steel works. They hope to be able, through their central buying office, to approach strong and responsible American firms representing groups of manufacturers of steel works' equipment. The representatives of such a group should preferably be of French extraction combined with American technical ability and these representatives should be in the position to take the blue prints and specifications prepared by the central purchasing office of the French steel industry and be able to name prices and date of delivery on every piece of machinery and very pound of material needed to enable the French steel makers to resume the manufacture of steel on the sites of their old plants.

G. A. HARRIS.

I suggest that the American manufacturer connects with a good exporting house with large domestic and foreign organization whose representatives are in touch with the foreign markets and whose experience in shipping and distribution, also knowledge of foreign requirements covering packing, terms, etc., is most essential. Much trouble and difficulty has been caused in foreign markets by lack of knowledge of the American manufacturer as to the various requirements and these difficulties can be obviated by such a connection as we suggest.

A. A. HUGHES, Northwest Trading Co.
Certain groups of steel manufacturers are now being formed in France for the purpose of concentrating and standardizing their purchases of material. It is not difficult for the American manufacturer to get in touch with these groups through some of the larger foreign trade houses who are well established in France.

MORRIS METCALF.

As far as the merchandising of this kind of goods to France is concerned, I have always maintained that there are three different ways of doing this; one, by personal contact; two, by mail campaign; and three, by advertising. The American manufacturer can, and no doubt will avail himself of all three; that is to say, where he has the necessary organization for doing an export business at all. Where he has not, and that is true of most cases, he will do well to employ a steel export house, which, like my own firm, has an organization ready at hand to attend to all the multifarious details of shipping, credit extension, insurance and other matters too numerous to mention, but all very essential if it is desired that fruitful results be obtained. Special knowledge of export conditions is a prime essential for business with France, which, more than any other country, will require all kinds of machinery used in building, construction work, shipbuilding and agriculture, not to forget electrical equipment.

VICTOR E. KARMINSKI.

WHAT classes of machinery will European countries be purchasing from the United States?

European countries will require from the United States highly specialized American machinery.

C. GREEN.

Various types of rolling mill and steel mill machinery, pipe and tube making plants, with possibly a few open hearth and blast furnace installations.

G. A. HARRIS.

General machinery, but tools especially.

A. A. HUGHES.

The classes of machinery to be supplied by the United States will be textile, construction, metal working and wood working. Their relative importance being in the order named.

A. M. GARBADE.

I believe European countries will be purchasing almost all kinds of machinery in this country. There will be severe competition, of course, but undoubtedly we will furnish our share.

MORRIS METCALF.

Labor shortage on the other side is sure to be an important factor. While Chinese coolies may be kept on for some time, the hostility of organized labor will have to be reckoned with, so that a keen demand for all kinds of labor saving machinery should presently develop. Gravity runways and elevator conveyors have played an important part in the prosecution of the war, and demand for them is likely to be enhanced once peace has finally been restored.

VICTOR KARMINSKI.

WHAT steel shapes will France and Belgium be most in need of during the reconstruction period (structural, plates, rails, etc.)?

From data at hand, it is impossible to state what steel shapes will be most needed by France and Belgium during the reconstruction period. France has lost more than a million tons of shipping, the greater part of which was probably of iron and steel. Mr. Tardieu estimates that nearly four million tons of steel will be needed to reconstruct the industries in the northern part of France. Only a detailed survey will disclose the relative proportions of each class of shapes that will be needed.

C. D. SNOW.

The requirements of France and Belgium in structural shapes, plates and rails will be general in character, and no particular class of these materials will be in demand over the others.

C. GREEN.

The quantity demand for construction shapes will be, I believe, in the following order: First, structural shapes; second, rail; third, sheets of all descriptions; fourth, wire products; five, plates.

A. M. GARBADE.

There should be a great demand, both in France and in Belgium, for structural shapes of every description, ship and tank plates will be in great demand, sheets, corrugated and plain, in short the entire line of American steel products.

VICTOR E. KARMINSKI.

WHAT are American chances of securing orders in competition with England?

We should say that the chances of the United States securing French orders for iron and steel in competition with England are very good, as there will probably be enough

Steel Industries Future Foreign Trade

TO EXPORT MEN BY THE BLAST FURNACE LIMITED TIME, EUROPEAN FIELD OFFERS STEEL PRODUCTS AND MACHINERY USED EAST OFFERS PERMANENT POSSIBILITIES.

business in the next few years to keep the mills in both countries busy. The American mills, of course, will have to meet the prices quoted by the English mills and a satisfactory system of financing the purchases must be worked out, as after the drain of four years of war, it will be manifestly impossible for French manufacturers to pay cash for the great amount of material that is needed.

C. D. SNOW.

America's chances of securing the majority of orders in competition with England are very poor.

C. GREEN.

American chances of securing some of these orders in competition with England I believe are fairly good, for the simple reason that I do not believe that England can take care of all the requirements and, further, the French are inclined, as a result of our close relations during the war, to favor us.

G. A. HARRIS.

For some time owing to great requirements, there should be enough business for both America and England and it might be mentioned that England will be very busy for some years rebuilding her merchant marine and looking after her old foreign trade, both in the Colonies and her other spheres in different parts of the world.

A. A. HUGHES.

I do not believe England will be in a position to supply much raw and semi-finished steel for outside markets in the next two years, owing to the enormous tonnages required by her ship building program, and the extensive demand of her colonies which have been depleted of stocks of all steel products during the past three to four years. In normal times it is utterly impossible for America to compete with England or Belgium, Germany and Austria owing to our higher cost of production and shipping cost.

A. M. GARBADE.

I think America's chances of securing a fair portion of this business are excellent. It is true that our prices may be higher than England's in many cases, but England cannot furnish it all and will be inclined to take care of her colonies. It should be borne in mind that England's cost of production will undoubtedly be much higher, also. An important factor in this connection, I think, is the fact that the French do not particularly care to do business with England if they can help it.

MORRIS METCALF.

England, of course, will to a certain extent compete with this country in supplying needed material to France, but against England's advantage on the score of proximity to the French market we have the better opportunity on account of our well developed methods of quantity production (enormously enhanced under the stress of war needs). I am optimistic enough to believe, therefore, that our chances of competing with England are better now than they ever were before and I think that a very fair share of American steel products, especially of the heavier kind, will find their way to French consumers.

VICTOR E. KARMINSKI.

WHAT can you say about the co-operation which the government will give to aid foreign trade expansion?

This bureau, through its commercial attaches, trade commissioners, and the officers of the Department of State will publish from time to time in "Commerce Reports" all available data regarding business conditions in foreign countries, in order to guide American manufacturers in their search for foreign markets. We also plan to send one or more trade commissioners to France and Belgium in order to make a detailed study of the mar-

kets for American goods in connection with the rehabilitation of industries. For this work, we shall desire the co-operation of all interests connected with the iron and steel industry, in order to assist us in obtaining men thoroughly qualified by education and experience to undertake this work. In addition to the proposed investigation in France and Belgium, one of our trade commissioners is about to start for the Far East, in order to make a special investigation of the markets for industrial machinery of all kinds in Japan, China, British India, Dutch East India and the Malay States. Trade commissioners have also been appointed to make investigation in Mexico, Venezuela, Columbia, British South Africa, the Dutch East Indies and the Straits Settlements. While these commissioners will not devote all their time to markets for iron and steel products, the development of trade in the products of that industry will be one of their important duties.

C. D. SNOW.

WILL France with the acquisition of the Alsace-Lorraine ore fields, be able to make full use of these deposits or will she have to export her surplus ore?

It is believed that after the iron mines of France are fully repaired and producing normal quantities of ore, France will not be able to make full use of all of the iron deposits. In 1913, the exports of iron ore extracted from French mines amounted to almost 10,000,000 long tons. In the same year, the net excess of exports over imports of pig iron amounted to about 66,000 long tons. The domestic production of steel ingots amounted to 4,000,000 tons, of which about 300,000 tons of blooms, billets and bars were exported. With the addition of the Lorraine mines to the French production it is evident that there will be a large surplus of ore unless the iron and steel industry develops at an unprecedented rate.

C. D. SNOW.

Time alone will tell whether France can absorb her entire Alsace-Lorraine ore production.

C. GREEN.

In the course of a few years France will probably have a surplus of ore for export.

A. A. HUGHES.

For some time to come France will be unable to make full use of her ore deposits on account of lack of rolling capacity and her total unpreparedness, due chiefly to not having the necessary skilled labor. Her natural outlet for this ore would be Germany, who has the facilities.

A. M. GARBADE.

I do not believe France will be able to make full use of all her ore. France will undoubtedly make enough steel for her own use and will probably engage somewhat in exporting it, but she has a great deal to learn about standardized and intensive production. The French people are not naturally adapted to the steel manufacturing and exporting business as are the Germans or the Belgians. The French are excellent at exporting soaps, perfumes and wine, but I think it will be some years before they are much of a factor in exporting steel in spite of their great natural resources.

MORRIS METCALF.

IF so, to what countries will she sell her surplus ore?

In 1913 Belgium took approximately 50 per cent, and Germany 40 per cent of the French exports of iron ore. These countries will probably continue to be the principal purchasers of French ore, especially in view of

the fact that the Germans will be deprived of the iron heretofore obtained from the Lorraine field.

C. D. SNOW.

Germany, when conditions return to normal, will undoubtedly be the purchaser of this surplus ore, should such overage become available.

C. GREEN.

In addition to supplying Germany with ore, and her policy in this respect is still doubtful, she will supply considerable tonnage to Italy, Spain, Portugal and the French colonies. Their relative consumption being in the order named.

A. M. GARBADE.

DO you think American products (as far as equipment for iron and steel manufacture is concerned) will be in greater demand in Europe or in the far Eastern countries?

If I am asked where the demand for equipment for iron and steel manufactures will be greater, in Europe or in the Far East, I am unqualifiedly of the opinion that the Far East offers by far the greater field. At first, no doubt, Europe will want a good deal more than the Far East, but after the first demand has been satisfied, it is the Far East that will come to the fore in providing opportunities for American steel makers. It must be remembered that the Far East is to a great extent still virgin ground. Developments to be expected in the Far East are much more far reaching than in Europe, where it will merely be a question of rebuilding. In the Far East on the other hand the work has to be done from the ground up, and while I do not deprecate the opportunities which present themselves to American steel makers in European countries, I still believe that the Far East will eventually prove to be (borrowing the title of a play now running on Broadway) "The better 'ole'."

VICTOR E. KARMINSKI.

It is believed that American equipment for iron and steel mills will be in greater demand in Europe than in the Far East. Japan controls the greater part of the iron deposits developed in China, and will naturally supply the larger part of the equipment. We do not anticipate that the development of new deposits in the Far East will call for as much equipment as the reconstruction and rehabilitation of the mills in European countries.

C. D. SNOW.

The Far Eastern countries undoubtedly offer better opportunities for American machinery to manufacture iron and steel products than the European countries. While the production in the Far East will not be as large as in Europe, the competition which our manufacturers will have to meet will be far less severe than in Europe.

C. GREEN.

I believe it would be better to develop the Far Eastern market. Demands from this territory should be continual and not periodical as the European demand undoubtedly will be. Furthermore, as you no doubt know, when a particular type of equipment is once satisfactorily installed in a territory it is very rarely displaced, due to the natural human tendency, of preferring to use what they understand, and even to stick to antiquated equipments, rather than to lose the initial investment.

A. M. GARBADE.

Difficult to say, but there should be a large demand for American products both in Europe and in the Far Eastern countries as soon as conditions become more settled.

A. A. HUGHES.

As near as we can see, the requirements for American iron-making and steel-making equipment will be in greater demand in the next year or two in Europe than in the Far East. We believe Japan has almost all the steel manufacturing equipment she wants. It is quite likely that India will be in the market for some. Some time in the future China is going to develop and when she does, we believe that the Chinese market will be far more attractive than the European. We cannot say when that time will come.

G. A. HARRIS.

to the production of its steel mills and furnaces and its yearly production is now estimated at 1,200,000 tons against 911,000 tons in the year 1913. Spain also has added somewhat to its former production which is estimated now at 400,000 tons. Norway does not specify the steel production in its official statistics. That of Sweden, however, apparently shows a considerable increase due to expansion of its manufacturing facilities. Eight hundred thousand tons of steel, approximately, are now made in Sweden, while only 582,000 were manufactured there before the war. The Russian steel production has declined. Figures, however, are somewhat unreliable owing to the political situation in Russia. During the year 1917 Russian reports gave the steel production at 3,362,000 tons, against 4,039,000 in 1913. India has added to its prewar steel production, and China is said to have doubled it. It is estimated to be now 200,000 tons in China, and 114,000 tons in India. The steel production in Japan is estimated to have reached 570,000 tons in the year 1917, against 320,000 tons in 1913. Steel is now manufactured both in South America and Africa, but the total production is still very small and of no influence on the market in general.

Comparative statistics as to the import and export of steel in the different countries are not always easily obtainable, as only a few countries make a proper distinction between steel and iron imports. From French statistics it appears that this country has more than trebled its prewar imports of steel so as to make up the loss of her steel works which were under German occupation and the increased consumption of steel caused by the necessities of the war. Also Italy has increased the imports of steel from 326,000 tons to 380,000 tons. Exports naturally have grown mostly on the American side as it was the United States which had to supply the deficiency of steel created by the war in Europe. England also has exported more than in the year 1913.

Coal.

The coal production of the United States shows a considerable growth against the year 1913, when it amounted to 541,562,000 tons. It has reached during the year 1917, 650,981,000 tons. With this exception, however, it appears that all the remaining principal producers of coal have lost in productive power. England, which during the year 1913, produced 292,040,000 tons of coal, was able to produce 252,000,000 tons only, during the year 1917; and the German production has declined from 191,000,000 tons in 1913 to 150,000,000 tons. The French production of coal was practically cut in half during the first years of the war, but now has recovered somewhat. China and Japan have been able to add to their prewar production and also Australia appears to have produced more coal during 1916 than before the war.

Commerce Reports.

In order that a more definite idea of the conditions of foreign steel industries and trade possibilities may be understood, extracts from a selected number of reports of the Bureau of Foreign and Domestic Commerce are published in the following articles. The complete reports have been issued by this bureau in the daily "Commerce Reports." In selecting these extracts no effort has been made to cover the subject of this article thoroughly, inasmuch as the amount of such information accumulated by this bureau is too vast in extent to permit such treatment of the subject in these columns. Such extracts have been selected as were considered of especial importance. An effort has been made to classify this information under the heads of countries.

The majority of the articles and extracts deal with the iron and steel industry, it has, however, interesting to note, the remarks of Pierce C. Williams, commercial attache, which appeared in the Commerce Reports regarding the coal needs of France:

"The post-war position of France with respect to coal supplies may make it possible to sell American coal in France during the year 1919. However, until there is some certainty regarding ocean freight rates it is impossible to say whether American coal can compete with English coal delivered f.o.b. French ports.

Before the war the annual consumption of coal in France was over 60,000,000 tons, of which 40,000,000 tons were produced in the country. It is estimated that the consumption of France proper during 1919 will be in the neighborhood of 55,000,000 tons. Allowance is made in this figure for the reduced consumption of coal by reason of the destruction of thousands of manufacturing plants in the north of France. To this figure should be added, however, 8,000,000 tons, which is the quantity of coal required to feed the iron, steel, and textile industries of Alsace-Lorraine, now in French occupation. This makes a total estimated consumption for France of 63,000,000 tons for the year 1919, or about the same as before the war.

Domestic Production Will Be Inadequate.

It is hoped that French mines during the year 1919 will produce at least 30,000,000 tons of coal. This is slightly in excess of the quantity of coal mined in the year 1917. While there may be a slightly greater production for the year, as mines in the devastated regions gradually resume operations, it must be remembered that the labor needed to mine this coal will in all probability have to be taken from mines in the center of France, with a consequent reduction in the output of that section. There is also included in this estimate of 30,000,000 tons the coal that will be obtained from that portion of Saar Basin lying in Alsace-Lorraine. The remaining 33,000,000 tons must be imported.

French Industry Reconstruction Problems

Extent of Industrial Damage in France—Estimate of Cost of Destroyed Industries—Group Selling for Iron Mining and Steel Mill Equipment Manufacturers Recommended.

By PIERCE C. WILLIAMS.

Commercial Attache.

The American manufacturer who looks forward to selling articles needed for the reconstruction of the destroyed industries of France should prepare for a revolutionary change in French methods of purchasing when the war ends. Instead of selling to thousands of individual buyers the materials each will need to rebuild his destroyed or damaged factory, the American manufacturer will deal with a small number of central purchasing agencies, representing groups of French manufacturers engaged in the same or related industries and assisted by the credit of the French government. Unless, therefore, the American manufacturer prepares for coöperative selling he may be under a serious handicap as far as furnishing industrial assistance to France after the war is concerned. Scattered American selling efforts will not be able to meet requirements of the huge purchasing power of several thousand French consumers exercised through state-aided buying organizations.

The French manufacturer has sometimes been regarded as the most individualistic of business men, and only the size and complexity of the task of industrial reconstruction of the invaded regions has caused him to accept such a radical change in his business methods as collective buying. He realizes that the task of repairing the devastation wrought during the last four years is too gigantic to handle with the individualistic and competitive methods that prevailed before the war.

Extent of Industrial Damage in France.

It is difficult to give any adequate idea of the extent of this damage. While the area that has been under German occupation for almost four years is small, as compared with corresponding regions in the United States, it should be kept in mind that prior to August, 1914, northern and eastern France, with Belgium, constituted one of the world's busiest workshops. In the invaded departments of France alone (Meurthe-et-Moselle, Ardennes, Somme, Aisne, Nord, Pas de Calais, etc.) there were nearly 26,000 factories and industrial establishments. These factories represented more than 30 per cent of the industrial output of all of France. Before the war the departments occupied by the enemy furnished France with the following proportion of the country's total production of

the articles named: Iron ore, 90 per cent; pig iron, 83 per cent; steel, 75 per cent; coal, 70 per cent; combed wool, 94 per cent; linen thread, 90 per cent; sugar, 65 per cent.

While the curtain of war (this report was written before the armistice declaration) shuts off all normal communication between the owners of factories in the invaded districts and their property, information is constantly being brought back to them in various ways. Workmen, engineers, and superintendents who were caught in the north of France when the German army rolled through have gradually worked their way back to Paris as their repatriation has been accomplished. The information they bring gives an answer to the question as to what remains of French industrial establishments in the invaded districts. In many localities and in numerous industries, it may truthfully be said that literally nothing remains. Coal mines have been flooded, and years will elapse before coal will be hoisted out of them again. Electric-power stations and their transmission lines have in many cases been thoroughly dismantled, the machinery carried off by the Germans, and the copper wire sold at auction. Practically all of the equipment in metal-working plants, all the cotton, linen, and wool spinning machinery, together with wool-combing plants and textile looms, have been systematically pillaged. Repatriated workmen bring back word that machines have been skillfully taken apart and all the copper and alloys in the bearings sent into Germany for remelting. In many cases, after this was done, the iron frame was broken up and turned over to German scrap-iron dealers. Steel structures have been taken down, and the sheet-iron roofs and steel columns and beams have either been sent back into Germany or used elsewhere in the war zone. Sugar refineries and breweries may be considered as completely destroyed. Machine shops finished just before the war broke out have been razed to the ground, and, if in the rear of the battle line the enemy has continued in operation certain plants that are capable of serving his purposes, there is every likelihood that they were later deliberately destroyed.

Estimated Cost of Destroyed Industries.

Figures give little idea of the material destroyed. But, because there is no other way, the following sta-

Extract from report of author for Bureau of Foreign and Domestic Commerce.

tistics are given as representing the cost of construction before the war of a few of the industries of northern France that are known to have suffered worst; they are furnished by a trustworthy and semi-official source:

	Francs.
Coal mines	900,000,000
Iron mines, blast furnaces, and steel works.....	2,500,000,000
Spinning of combed wool (2,400,000 spindles).....	192,000,000
Spinning of cotton (2,800,000 spindles).....	184,000,000
Spinning of flax (500,000 spindles)	100,000,000
Wool weaving (56,000 looms).....	92,000,000
Weaving of cotton cloth (29,000 looms).....	46,000,000
Central electric stations and lines of distribution (300,000 kw.)	250,000,000
Machinery and electrical manufacturing plants..	500,000,000
Sugar refineries	135,000,000
Breweries	137,000,000
Small machine shops	350,000,000

These figures do not include the value of the land on which buildings stood; nor (with the exception of the coal mines, the blast furnaces, and steel works) do they include the value of the buildings themselves. Neither do they include the value of stocks of raw materials and merchandise in course of manufacture. The loss of these stocks may be considered as complete.

In addition to the industries mentioned, there were many other flourishing trades represented by up-to-date installations. Ice-making plants, glass works, public works, gas and water works, pottery works, oil works, flour mills, printing plants, establishments for dyeing and bleaching textiles, food-conserving plants, chemical and fertilizer works, etc., abounded in the invaded regions of France. Their buildings, tools, and stocks of merchandise represented an enormous outlay of capital.

The cost of replacing these industries today is conservatively estimated as nearly three times the original cost.

Problems Faced by the French Steel Industry.

The restoration of the French steel industry will serve as a final illustration of the need for group selling on the part of American suppliers of iron-mining and steel-works equipment.

The steel industry, for obvious reasons, must be restored as quickly as possible, so that it may furnish iron and steel products to replace the other industries destroyed by the war. The restoration of the steel industry alone will be an enormous undertaking. Ninety per cent of the 21,000,000 tons of iron ore mined in France came from the mines of the department of Meurthe-et-Moselle; 85 per cent of the 5,000,000 tons of pig iron produced in France was smelted in blast furnaces in the eastern and northern districts of the country; and 75 per cent of the ingots made in France were cast in the steel works of the regions now occupied by the Germans.

How can this vital industry be reconstructed except by collective effort? To get some idea of the

need for coöperation, let us reverse the picture. Imagine western Pennsylvania ravaged by earthquake and fire. Houses lie in ruins, railway tracks are torn up, bridges are broken down and lie in the bed of the streams, coal mines are flooded with water and their hoisting apparatus is bent into unrecognizable forms of twisted metal, blast furnaces and steel works are piles of crumbling brick. Imagine this blackened and uninhabited country suddenly reepled and eager to resume its former industrial activity. Unable to find machinery or materials near by, the stricken manufacturers of Western Pennsylvania must send 3,000 miles across the Atlantic ocean to France for help. In such a situation what would they do? Unquestionably they would first of all band themselves together for coöperative buying, so that there should not be destructive competition and a wasteful scramble for materials. And when this joint effort had secured an approximate inventory of what remained and gained a fair working idea of what was needed in the way of tools, machinery, and raw materials, would not the American victims of such a disaster next look for some collective selling counterpart to their collective purchasing?

In any case present indications are that the French steel makers whose plants the war has blotted out of existence will attempt to bring about the restoration of their blast furnaces, converters, and rolling mills by collective buying through the Comptoir Central d'Achats or some other organization affiliated with it. The adoption of this principle for after the war is a natural outcome of the tendency toward concentration, integration, and association that characterized the French steel industry before the war. In place of numerous small steel plants in existence 15 or 20 years ago, the steel production of France today is centralized in a comparatively few strong companies, and many of these companies are completely integrated; that is, they operate their own coal mines and their own by-product coke ovens; they reduce the iron ore hoisted out of their own mines in their own blast furnaces, and they convert the pig iron into steel in their own Thomas converters and Martin furnaces. Over 90 per cent of the steel output of France is represented in the Comité des Forges, the iron and steel association of that country. And for some years the French steel makers have sold a large part of their product through comptoirs or central selling offices. It is not surprising, therefore, that the French steel makers, when confronted with the task of meeting the overwhelming disaster which the war has brought them, should pursue their policy of closer trade association to the point of adopting coöperative buying of reconstruction materials. The French steel men believe that one of the best ways for America to help them is by placing at their disposal as soon as the war ends some tried form of coöperative selling.

Tremendous Blow to German Iron and Steel

The Economic Effect of the Loss of Alsace-Lorraine—Effect of the Restoration of This Territory on French Iron and Steel Industry—French Even More Dependent on German Coke Now.

THE economic loss to Germany involved in the cession of Alsace-Lorraine, is discussed by Dr. Felix Pinner, financial editor of the *Berliner Tageblatt* in the issue of that paper for October 19. The author concedes that the acceptance of the terms of President Wilson has given an international aspect to the Alsace-Lorraine question and suggests that it might be worth examining the economic value of that territory to Germany. He points out that Alsace-Lorraine is not only one of the most highly developed manufacturing parts of the Empire, but also, what is far more important, one of the chief sources of raw materials with which Germany is not any too well supplied.

The mere loss of a manufacturing industry, no matter how highly developed, is far less serious than the loss of a supply of raw materials. Manufacturing industries based largely on foreign raw materials may be easily transplanted; the productive forces, the capital, the enterprising spirit, the technical training and commercial connections involved are comparatively mobile and may be restored after overcoming a certain amount of disturbance during the period of transition. The loss of raw materials, on the other hand, is final and irreplaceable. The mere mention of ore, potash, and petroleum is sufficient to indicate the significance of Alsace-Lorraine as regards to raw materials.

Importance of Petroleum, Potash, and Iron Ore Deposits.

As to petroleum, Alsace produced prior to the war 42 per cent of the total amount of 120,000 tons of crude oil produced in Germany, and while the yield has increased somewhat lately, it is still of slight importance as compared with the total German consumption of petroleum. The potash deposits are of far greater importance, both from an economic and politico-economic standpoint. It is true that the potash deposits in the other parts of Germany are more than sufficient for domestic consumption and export. But the loss of the Alsatian deposits (about 10 mines belonging mostly to the German potash syndicate) will deprive Germany of the world monopoly which it has heretofore enjoyed and take away from it one of the few weapons of economic defense. While the statements in the Allied press to the effect that the Alsatian deposits will be sufficient to provide potash for all countries outside of Germany may be exaggerated, the fact remains that the loss of these deposits is of extreme importance. The potash monopoly, the writer asserts, enabled Germany not only to fix the prices for

foreign markets above those for domestic consumption, but also to offer an important product in exchange for raw materials produced by countries depending on German potash. The loss of the Alsatian deposits will therefore put an end to the independent export policy of Germany as regards potash and will force it either to cut prices or enter into an agreement with the new owners of the Alsatian deposits.

The most severe blow will be the loss of the iron ore deposits. It is safe to state that without the acquisition of the Lorraine iron ore deposits in 1871 the astonishing development of the German iron and steel industry would be unthinkable. From a few million tons the German iron and steel production increased within the two decades preceding the outbreak of the war to 19,000,000 tons, far outdistancing the British production and being 10,000,000 tons behind the American production. The importance of the Lorraine deposits is not indicated by the iron and steel production of Alsace-Lorraine (2,286,354 tons in 1913), but by the fact that the entire iron and steel industry of the western part of Germany, particularly in the Rhenish Westphalia and Saar districts, depended to a large extent on Lorraine minette. The Lorraine and Luxemburg mines (the Luxemburg mining industry being closely connected with that of Lorraine and the separation of Lorraine will probably mean the loss of Luxemburg as a member of the German Customs Union) supplied in 1913, 28,500,000 tons of iron ore out of a total of 35,000,000 tons for the whole of Germany, or 77 per cent on the basis of metallic content. The loss of Lorraine would, therefore, mean that for a large part of its iron ore needs Germany would depend on foreign countries, while in 1913 it imported foreign ore to the extent of about 14,000,000 tons, with a metallic content of 7,700,000 tons. It is true that Germany will still be able to import ore from Sweden, Spain, Russia, and, perhaps, even from France, but the raw material basis of its industry will be narrowed to such an extent as to endanger its maintenance and further development.

Effect of the Restoration of the Territory to France on the Iron and Steel Industry.

In considering the Alsace-Lorraine side of the question, Dr. Pinner points out that the restoration of that territory to France does not necessarily mean the transfer of Germany's position in the iron and steel industry to that country. It is claimed by the writer that France has neither the organizing ability for the large-scale industry nor the fuel supply required to maintain an extensive iron and steel industry.

Translation by Bureau of Domestic and Foreign Commerce.

British Report on Future Steel Trade

Recommendation That Imports of Manufactured Products of Iron and Steel from Present Enemy Countries Be Prohibited During Period of Reconstruction—Committee's Anti-dumping Views.

By CONSUL GENERAL ROBERT P. SKINNER.

THE British government has made public an important commercial report dealing with the iron and steel trades, issued by the departmental committee appointed by the board of trade to consider the after-the-war position of this industry. In the report of the committee on the iron and steel trades it is pointed out that the experience of the last three years has shown that under the stress of modern war the safety of a nation is in great part determined by its command of resources of iron and steel, and that the more nearly self-sufficing a nation can become the greater will be its power of self-defense. The report calls attention to the fact that whereas in 1880 this country produced 54 per cent of the total output of Great Britain, Germany, and the United States, its production was only 28 per cent in 1900, in 1913 it had fallen to 17 per cent, and today it is probably 15 per cent.

To restore the trade to something like its old position the committee recommends that all imports of manufactured or semi-manufactured products of iron and steel from present enemy countries be prohibited during the period of reconstruction; that all necessary ores and minerals be admitted free, and that no raw materials be sent to present enemy countries from British Dominions or colonies or from mineral or other resources under British control. It is further recommended that British ships shall not carry raw materials or manufactured iron and steel from neutral ports to ports in present enemy countries, or to neutral ports for ultimate dispatch to present enemy countries, and that careful consideration be given to the question of allowing ships of present enemy countries to carry goods to or from British ports or to coal at any British coaling station.

"Anti-dumping" Views of Iron and Steel Committee.

Looking forward to the period when something like normal conditions prevail, the majority of the committee members have much to say on protection. In their opinion the maintenance and expansion of the iron and steel trades is "an imperative function of national policy," and "the aim of the industries themselves, and of the empire as a whole, should be to become as nearly as possible self-sufficing in respect of the fundamental products of iron and steel." The evidence of producers, manufacturers, and importers of iron and steel was almost unanimous that

competition, through dumping, particularly of semi-finished material and finished cast-iron goods, had reached such a pitch that the British production of iron and steel "was seriously restricted and imperilled;" further, that "the industries commanded no confidence among the general investing public, and the cumulative effect of inveterate underselling was not only to injure present prosperity but also to thwart possible growth in the future."

As a remedy for these evils the committee makes the following recommendations:

That anti-dumping legislation be introduced in the United Kingdom similar to that in force in Canada.

That no iron or steel shall be imported into the United Kingdom which does not bear clearly and indelibly a readily recognizable mark of origin.

That every endeavor should be made to coordinate the economic policy of the United Kingdom with that of the dominions and of the empire generally.

That customs duties be imposed upon all imported steel and manufactures thereof, and that a specific duty should be levied upon each class of commodity.

That there should be maximum, general, and minimum tariffs, and that the amount of specific tariff should be varied readily according to the changing demands of national policy.

That foreign syndicates and their accredited or unaccredited representatives should carry on commercial and industrial activities in the United Kingdom only under license from the government.

The iron and steel industry of Great Britain had an unprecedentedly good year in 1917, but practically the whole output went to certified businesses. Control of essential metals became increasingly stringent during the year, thus insuring their application to the most vital needs of the situation, and at the same time attention was given to native ores and to the improvement of equipment for smelting and manufacturing iron and steel. More blast furnaces were brought into service, and this movement is still in progress. The outstanding features were the shortage of material for the equipments of the Allies and the strenuous activity in all branches of the industry to meet the needs of war manufacture. The shipbuilding program made heavy demands upon the output of steel and further aggravated the shortage resulting from the immense appropriations for munitions and other war purposes, notwithstanding what was done to develop a larger productive capacity. Smelters were called upon to assist in this situation by applying more of their blast furnaces to the production of basic pig iron.

Extract from report of author for Bureau of Foreign and Domestic Commerce.

Chinese Demand for U. S. Iron and Steel

Chief Increase in Chinese Imports from the United States Made in Iron and Steel Products—Railroad Expansion Should Afford Opportunity for Steel Exports.

By CONSUL GENERAL GEORGE E. ANDERSON.

THE chief increase in imports from the United States, although perhaps not of so much significance in a general trade way, has been in iron and steel products, tin plate, nails, and similar goods. Imports of steel plates have been largely for the use of Hongkong shipyards. The movement was of considerable importance until the American embargo affected the trade. Imports of iron and steel bars, rods, and similar materials in 1917 were about 60 per cent more than in 1916 and are beyond comparison with previous years, but an accurate estimate of the value of such materials coming from the United States cannot be obtained. Another important item in such lines is that of tin plate. For various reasons Hongkong has come to be an exceptional distributing market for tin plate throughout this part of the Far East. Imports from the United States into the Hongkong market alone, not including shipments ordered through Hongkong but forwarded direct, were valued in 1916 at about \$1,250,000. The trade in the past year was somewhat smaller, probably not exceeding \$1,000,000 in value, because of an overstock in the first part of the year

and also because of the effective embargo put upon the exportation of this material in the closing months of the year. The import of nails, also a heavy item in the iron and steel list, was not up to the volume of 1916, during which year an overstock was accumulated in the market which has taken some time to work off. Imports of small iron and steel bolts, nuts, piping, and fittings of all sorts increased greatly.

Imports of American hardware increased about 20 per cent, according to the statement of a Hongkong importer, but it is impossible to give any accurate figures. Practically all of some lines of hardware now coming into this market is American. Imports of American railway materials have increased, the United States furnishing most of the new equipment coming into the field, including a new lot of locomotives and about 20 miles of rails for the Sunning Railway. Most of the automobiles now imported into Hongkong are American. The number increased during the past year very materially, although it is still far below the average for a city of Hongkong's population.

Some Aspects of the Russian Iron Industry

Principal Russian Iron Ore Deposits Found in Ukraina—Iron and Steel Mills Located in Proximity Thereto—Industry Depends on Foreign Capital.

WITHIN the boundaries of the Ukraina are found the principal available deposits of iron ore in Russia. The development of the iron-ore deposits of the Krivoi Rog district has been mainly responsible for the rapid growth of the Russian iron and steel industry, which now depends to an extent of about 70 per cent on the iron ore in the southern part of the country. In 1913 the total output of iron ore in the two districts of Krivoi Rog and Kerch amounted to more than 7,000,000 tons, of which the latter contributed about 500,000 tons. The chief iron-ore deposits of the Ukraina are found in the western part of the government of Yekaterinoslav and the eastern part of Kherson, in what is known as the Krivoi Rog district, situated at a distance of from 200 to 250 miles from the rich coal deposits of the Donetz Basin, where

good coking coal and anthracite are mined in large quantities. As a result of this comparative proximity of the Donetz coal fields, the southern iron and steel industry has far outdistanced the older iron industry in the Ural region, where a lack of coal and abundance of forests make charcoal the only available fuel. In addition to the Krivoi Rog deposits, a good grade of iron ore is also mined in the Kerch district, in the Crimea, which, on account of the favorable location of the mines in regard to transportation by water, is exported to a considerable extent, while the Krivoi Rog ore is consumed almost entirely by the local furnaces. Mention should also be made of the deposits at Korsak-Moghila, near Berdiansk, in the government of Taurida, which are situated more advantageously in relation to the coal supply.

The iron ore deposits in the Donetz Basin are also utilized to some extent in combination with the richer

Extract from report on "The Economic Importance of the Ukraina," by the Bureau of Foreign and Domestic Commerce.

Krivoi Rog ore. The iron and steel mills are located in proximity to the principal iron ore deposits, but there are also some in the Donetz basin in the Don territory, so that either iron ore or fuel has to be transported for a considerable distance. The first successful mill established by Hughes in 1872 was located in the Donetz basin, but the industry has developed largely in the Krivoi Rog district, and the extensive works of the New Russian Company are located at Yuzovka (named for Hughes), in the eastern part of the government of Yekaterinoslav, adjoining the Don territory. In 1913 there were in operation in the whole southern territory of Russia 14 iron and steel mills, employing about 58,000 men, with an output of about 3,500,000 tons of pig iron, or two-thirds of the total production of Russia. Russia depends to a predominating extent on foreign capital,

mostly Belgian and French, and is decidedly a large-scale industry, with an output that had been running for some years prior to the outbreak of the war beyond the consuming capacity of the country. The chief products of the southern mills are semi-manufactures, rails, structural iron, sheets and plates, and wire, which are marketed largely through the central selling syndicate of "Prodameta."

In addition to its iron ore deposits, the Ukraina contains deposits of other valuable minerals, like manganese and graphite. The manganese deposits are found in the Yekaterinoslav district, where about 280,000 tons of manganese ore were mined in 1913, of which about 37 per cent was exported. Graphite was obtained in the vicinity of Mariupol, in the southern part of the government of Yetkaterinoslav, to an extent of 2,000 tons of ore.

Japanese Industrial Development Reviewed

Iron and Steel Demand in This Country Has Undergone a Great Increase During Period of the War—Restriction of United States Export Accelerates Independence—High Grade Steels Needed.

By CONSUL GEORGE H. SCIDMORE.

BEFORE the war Japan relied chiefly upon Great Britain, Germany, and India for supplies of iron and steel, a small portion of its requirements being satisfied by domestic output. Since the outbreak of hostilities the demand in this country has undergone a great increase, with the development of shipbuilding and machinery-making industries, while foreign supplies have been greatly curtailed or entirely suspended owing to export embargoes. This state of affairs has gone a long way toward stimulating iron founding and steel making in this country, and notable achievements have been attained in this direction. Nevertheless, in the face of the great reduction in foreign supplies, coupled with a great increase in demand, there has been a tremendous advance in price. For instance, the price of pig iron in September was quoted at about 540 yen (\$269) per ton, as against the pre-war price of about 35 yen (\$17.45). The advance in shapes and plates also ranges from 7 to 14 times the figures quoted before the war.

Since the United States prohibited the export of iron and steel last year there has been marked decline in imports. During the last few months there have been increased imports, supplies being furnished under the agreements for the supply of Japanese steamers in return for American shipbuilding materials. Yet the total imports from the beginning of

this year to the end of August showed a decrease of 20 per cent in quantity on the corresponding period of last year. There was, however, a considerable increase in value, the imports during the above-mentioned period this year being valued at 201,450,000 yen (\$100,322,000), which shows an increase of 92,210,000 yen (\$45,920,000) over the corresponding period of last year.

As mentioned above a considerable advance has been attained toward making Japan self-supporting in regard to supplies of iron and steel. This will be seen from the following table, showing the demand, the quantity supplied by domestic output, and the imports during 1914 and 1917:

		Steel.		
		Demand.	Supplied by home output.	Imports.
		Tons.	Tons.	Tons.
1914	.....	690,000	282,000	408,000
1917	.....	1,205,000	529,000	676,000
		Pig Iron.		
1914	.....	471,000	299,000	172,000
1917	.....	733,000	501,000	232,000

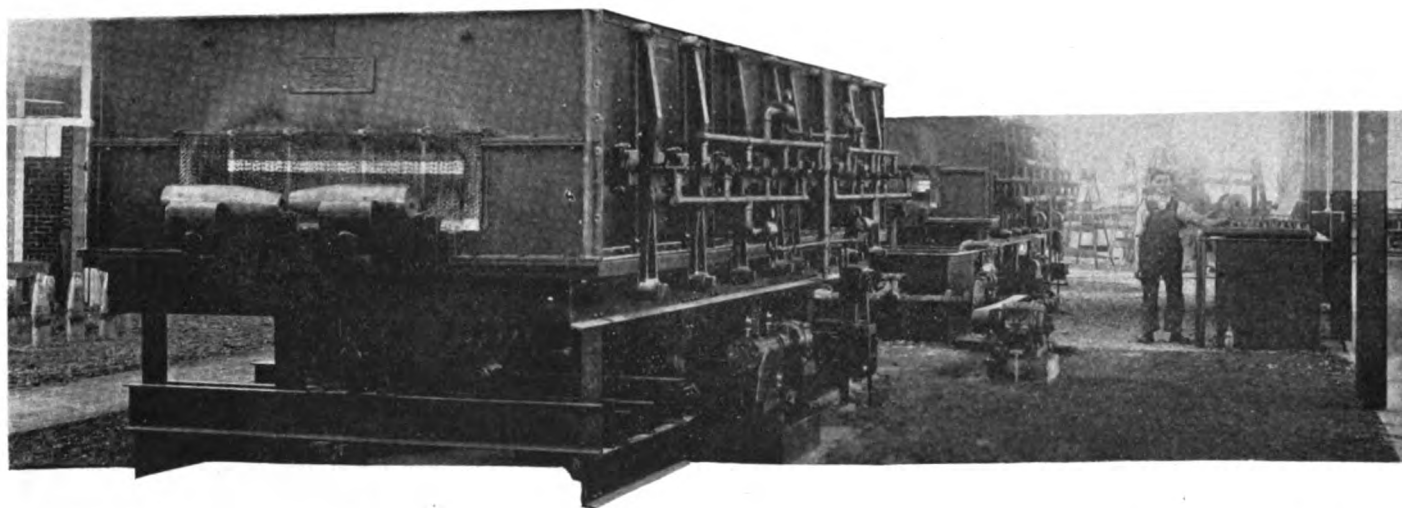
It will be seen that during four years the demand for steel in this country has about doubled, and that while imports have increased by about 50 per cent the increase in the self-supplying capacity is no less than by 170 per cent. It must be added, however, that certain superior kinds of steel goods are still impossible of production in this country.

Extract from report of author for Bureau of Foreign and Domestic Commerce.

Progress Shown in REVIEW OF TECHNICAL ADVANCES IN STEEL INDUSTRY DURING NINETEEN-EIGHTEEN

Although quantity production rather than technical refinement marked the keynote for 1918, many technical developments, improvements, and advances were made. War production demands, rigid specifications, and adverse conditions developed the resourcefulness of operating officials. The account of the consequent technical developments as related by prominent engineers in the following pages is of particular interest now, at the close of the great struggle, and will be of especial value in meeting after-war competition.

Heating Furnace	A. F. Mitchell
Electric Furnace	A. V. Farr
Refractories	Raymond Howe
Steel Foundry	John H. Hall
Forging	Harry Freeman
By-Product Coke	C. J. Ramsburg
Blast Furnace	F. H. Wilcox
Open Hearth	F. Crabtree
Steel Castings	W. A. Janssen



Heating Furnace Progress During 1918

Urgent Government Need Produces Many New Designs. Improvements Made in Furnace Control, Economical Application of Heat, Ease of Operation, Efficient Supervision and Design.

By A. F. MITCHELL,

Metallurgical Engineer, United States Steel Corporation, Ordnance Department.

The urgent needs of the government for various furnace products at the beginning of the year, resulted in many types of furnaces being hurriedly designed and placed in operation. Quantity rather than quality, predominated in the minds of furnace designers. As the year progressed, the imperfections appearing were gradually eliminated by more mature designs which improved the quality, and increased the output. Many old theories were forced to give place to more modern practice of producing a specified product.

Burners have been designed, providing a definite known mixture which has done away with the evils and the loss due to improper combustion. The control of gases by means of flues, dampers and vents properly located have aided greatly toward uniformity of heat. This has in many cases, replaced the old methods of allowing the flame to come directly in contact with the steel, causing heavy oxidation and uneven heating. These changes have not only increased the quality of the product by making it more uniform

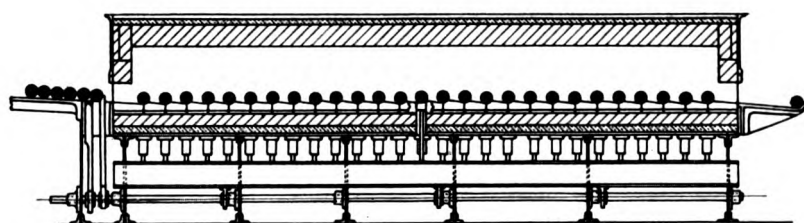


Fig. 1—Showing longitudinal section of shell heating furnace.

Some of the lessons learned by manufacturers, are that indifferent heating with any old kind of a furnace would not give a product that would meet modern specifications, and that "the rule of thumb" methods must give way to properly designed and operated furnaces.

The most important progress was made first in furnace design; second, in durability; third, economical applications of heat; fourth, furnace control; fifth, ease of operation, and sixth, efficient supervision.

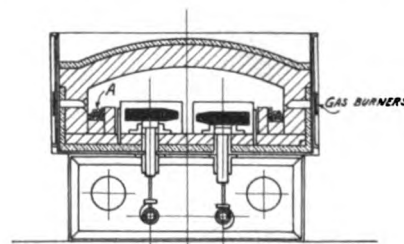


Fig. 2—Cross section. A—Refractory material.

in structure, which will aid future heat treatment operations, but has reduced the cost of manufacture, by a large saving in fuel, scrap and maintenance.

Forging furnaces have been greatly improved by enlarging the heating chamber which insures better distribution of heat, and consequently a thorough saturation of the steel. Heretofore, the question of forging temperatures has been largely left to the judgment of the furnace operator, and has given variable results. Progress has been made by the use

of modern thermocouples and protecting tubes which have aided greatly in obtaining and recording the desired temperatures which have produced more beneficial forging results. This does not necessitate determining of the actual temperature, but rather a comparative temperature with variables constant.

While considerable attention has been given to improvements in forging furnaces, this has not kept pace with the great progress in design and equipment of heat treating furnaces. This is due to the fact that in heat treatment of steels, the range of temperatures is prescribed according to the various known transition points to meet the required specifications. Therefore, furnace design and operation must be such that these temperatures can be produced and maintained. Probably more development has been made along the type of continuous furnaces. Particularly in the heat treatment of shells. A type of the furnaces mentioned above is shown in the accompanying Fig. 1. The shells are fed into this furnace automatically. In the furnace, they are supported upon cast-iron plungers operating through the furnace bottom and driven by a cam operated mechanism propelled by a variable speed motor. The shells while heating, are not only kept separated by this method, but are held several inches above the furnace bottom and rotated, insuring uniform heating which determines the final results.

The shells not being in contact with the furnace bottom, the heat absorption is more rapid, reducing the time in furnace, and a consequent saving of fuel.

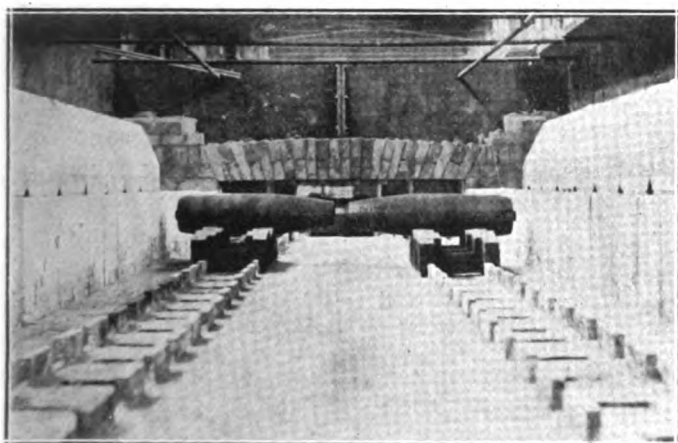


Fig. 3—Interior view of shell heating furnace. The exterior of this furnace is shown in the illustration above the headline of this article.

The management having determined the time the product shall remain in the furnace, the operating mechanism is set accordingly, which provides against any oversight or lack of knowledge upon the part of the operator. Still another important feature of this furnace is the method of fuel application. The fuel used may be natural gas, clean producer gas, or water gas under slight pressure, by means of a booster. The method of introducing the fuel is through a

burner, which contains an automatic proportioning feature, the mixture being so balanced that the resulting furnace atmosphere is reducing in its nature, resulting in a minimum oxidation. This is accomplished by the method of introduction. In place of fuel being injected directly into the furnace, and thus coming in contact with the work in process, it is burned upon a bed of incandescent refractory material. (See Fig. 2) the heat being deflected against the roof, from which

The unusual and heavy war demands upon steel plants and forge shops brought the realization of how little is really known about the design, construction and operation of heating furnaces. Problems never encountered before had to be met, but the correct and economical operation of the heating furnace is still in the experimental stage. It undoubtedly will interest the readers of this article to know that commencing in this issue W. Trinks starts the first installment of a series of articles on the subject of heating furnaces.

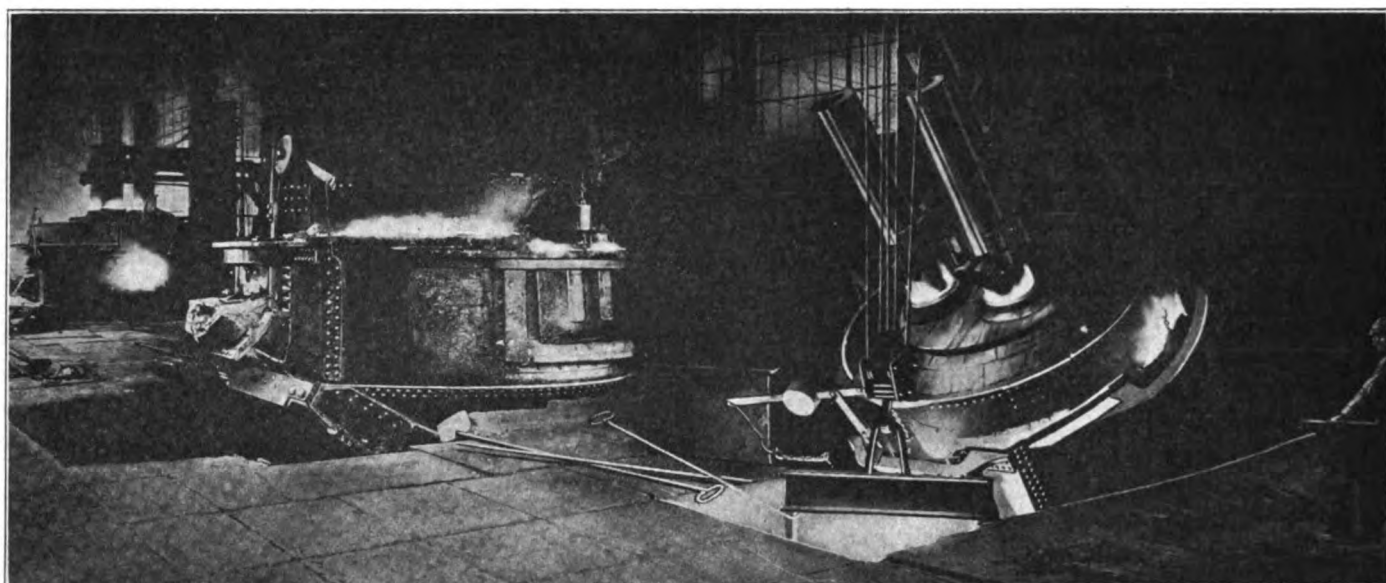
point it is radiated upon the work. Waste products of combustion being very small, stacks are not necessary. When the shells reach the exit, they are automatically ejected either into the quenching medium, or upon a cooling bed. The value of this furnace is increased by the installation of an authentic pyrometric system. This furnace is not only well adapted to shell heating, but with slight interior modifications, could be easily adapted to the heat treatment of various products of uniform size and design, such as axles for railway cars and locomotives; also heavy duty truck axles, and annealing of gas bottles, etc.

The question of fuel conservation during the past year has been given much attention by many competent engineers, and as a result, furnace construction is made to keep pace by adequate insulation of roof and side walls.

The first cost in furnace construction, with proper insulation, is very little in excess of the old style method of construction, but the increased efficiency, and the saving of fuel, soon save many times over the difference in first cost.

Furnaces using oil as a fuel, have been very much improved. This is due to greater efficiency in furnace and burner designs which coördinate in proper application and appropriation of heat.

Electric heating furnaces, while still somewhat in the experimental stages as to application, have made many advancements, particularly in the replacements of oxidizing parts by refractory materials. While the use of these furnaces has been somewhat limited in scope of operations, they bid fair to become more popular.



Electric Furnace Improvements During 1918

Efforts Largely Directed to Increase Output—Linings, Tilting Apparatus and Cooling Given Considerable Attention—Tendency Toward Larger Power Supply—Comparative Data—Illustrations.

By A. V. FARR,

Sales Manager, Hess Steel Corporation.

The United States has attained a commanding position in the world's market as a producer of electric steel, and the year 1918 has emphasized this leadership. The rapid growth of electric steel is shown by the number of installations which have been placed in operation during the past two years. A number of technical improvements have been made in the electric furnace in this period which are described in this article.

An investigation of these improvements would seem to be extremely profitable to everyone engaged in the steel industry. The number of types of furnaces has materially increased. A number of new types of furnaces have been designed and placed on the market during the past two years. The various important types of furnaces in operation at the present time are considered separately in this article and the technical improvements made in each are summarized.

Heroult Furnaces.

The recent changes in the design of the Heroult furnace of the smaller type may be summarized as follows:

During pouring, the new furnace is arranged so that the spout remains almost stationary and the ladle also remains stationary during the operation. This is accomplished by tilting the furnace about a hinge, the axis of which passes directly under the

spout, instead of rolling the furnace on rockers as in the older design. A small tilting motor is now used with a consequent saving in power in tilting the furnace. The furnace is lifted into the pouring position by means of connecting rods, actuated by gear wheels revolved through pinions and a worm gear by the motor. In addition to this, a suspended counterweight box attached to connecting rods by levers is employed. The time of tilting has been shortened by using large transformers. On the six ton furnace, a 1,500 K. V. A. transformer is used as against a 1,200 K. V. A. on the old type.

The shell of this furnace has been made stronger and simpler. A greater thickness of brick work is used at the bottom underneath the slag line, where it is most needed. The present shell is a simple cylinder having a flat bottom.

The leads from the transformer to the furnace have been reduced and re-actance cut down by placing the transformers at such a height that no connecting busses are required between the transformers and the transformer end of the flexible cable. The Heroult furnace now uses one three-phase water cooled transformer in place of three single-phase self-cooling transformers. The cooling water is conducted through the transformer through the electrode holders and then through the electrodes. The waste water flows to a bosh plainly visible to the furnace operator.

The transformers used are especially constructed for electric furnace work so that a breakdown in the transformer is an extremely rare occurrence.

The most striking developments made in the large type Heroult electric furnaces during the year are ably described in the paper read by T. W. Robinson, vice president of the Illinois Steel Company, before the fourteenth general meeting of the American Iron and Steel Institute, and which was published in the June issue of THE BLAST FURNACE AND STEEL PLANT.

Snyder Furnace.

Most of the furnaces built by the Industrial Electric Furnace Company, which now builds the Snyder furnace, are of a multi-phase type ranging in size from one to five or six tons per heat.

The roof opening feature has been applied to the largest size furnaces and it has been demonstrated that this is beneficial to both the side walls and roof life and that three and four tons of scrap are put into the furnace at a single bucket full through drop bottom buckets. Records as low as two minutes from the pouring of one heat to the turning on of power of subsequent heat are frequent.

The manufacturers have abandoned the practice of having water cooled pocket for bottom contact inside the furnace.

Improvements have been made in the electrode jaws and conveniently arranged hand wheels are provided for handling the electrodes. The multi-phase furnaces now being shipped out are generally equipped with standard type automatic regulators.

Considerable work is being done in the use of rammed ganister roof centers as a substitute for silica brick.

A number of Snyder furnaces are now operating with basic linings and the spout has proven sufficient for handling basic as well as acid linings.

Gronwall-Dixon Furnace.

The improvements made in the Gronwall-Dixon furnace have been mainly directed toward greater output to meet the tremendous demand for steel and the increased cost of labor. The more recent installations of these furnaces have been equipped with much larger transformer capacity than was formerly considered necessary.

Another feature in connection with larger power supply is the application of this power during the melting period at a materially higher voltage than was formerly considered desirable. This practice has been advocated for the smaller furnaces and considered to be vitally important in the 10-ton furnaces, enabling the whole charge to be easily melted without the use of hooks or bars to push the melted scrap down into

the bath. Thus the 10-ton furnaces of this type have been producing 12-ton heats of steel for government purposes in periods varying according to the grade of scrap from 3½ to 5 hours. At least one slag having been removed in all cases owing to the impurities of the scrap. This practice is perhaps noteworthy most especially on account of the view held that furnaces of 10-ton capacity could be operated only on liquid metal. Increased furnace production accompanied by close adherence to specifications has been accomplished, not by any radical discovery or new processes of operation, but rather by greater skill in operation. For foundry work, basic lining is recommended in order to produce steel of greater purity. A number of basic lined three-ton furnaces are in operation melting scrap containing .07 phosphorous and sulphur for the production of castings containing sulphur and phosphorous of .04 without removing the slag, the heat being of one and one-half to two hours duration.

The Greaves-Etchells Furnace.

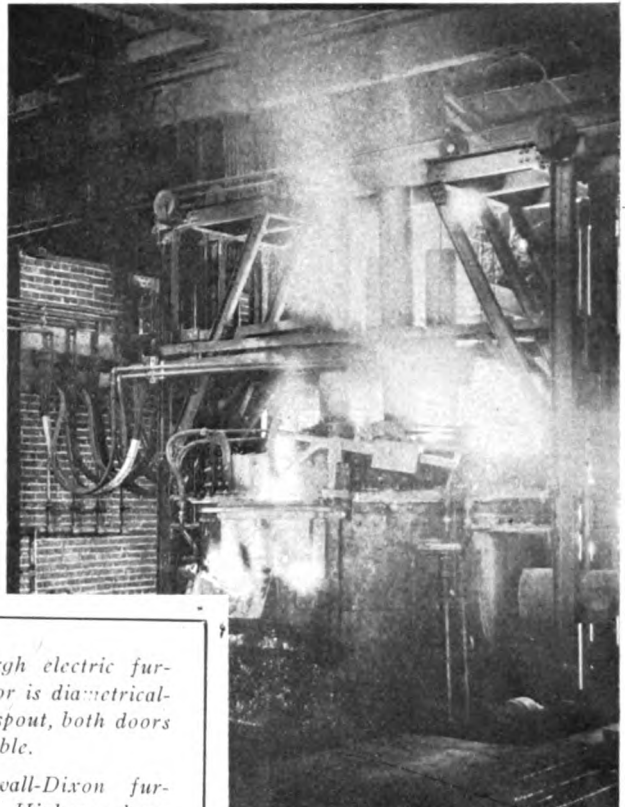
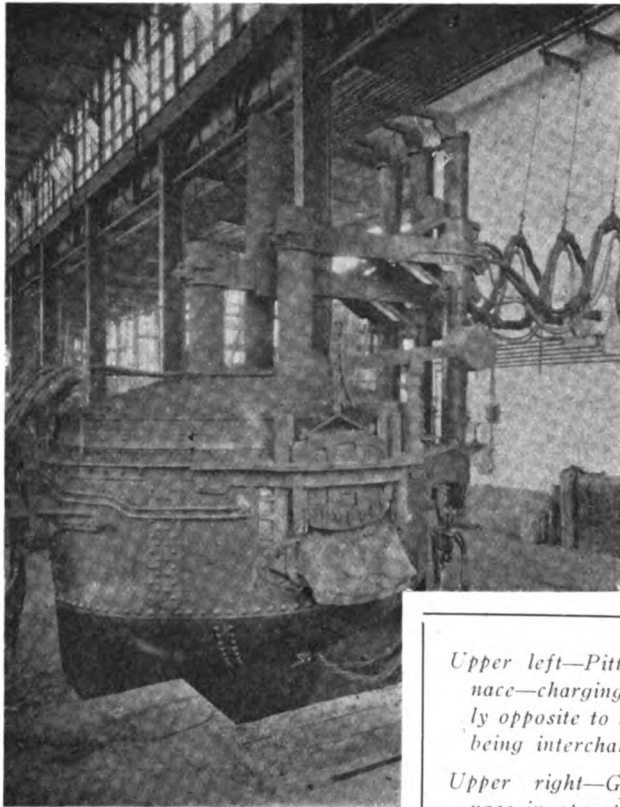
The Greaves-Etchells furnace which was introduced in 1914, is an arc-resistance furnace, having two phases of a three-phase low tension supply connected to the upper electrodes and the third connected to the bottom of the hearth.

In a recent test made of 12 heats of nickel chrome vanadium aeroplane steel, cold scrap was used and the metal treated with two slags and held while the various constituents were checked and regulated, the average time for a three-ton heat was three hours, with a power consumption of under 700 kw hours per ton. On a six-ton furnace cold melting, the time averages five hours with a power consumption of 650 units per ton. Two 30-ton furnaces are now being installed in Europe for hot metal process.

Booth-Hall Furnace.

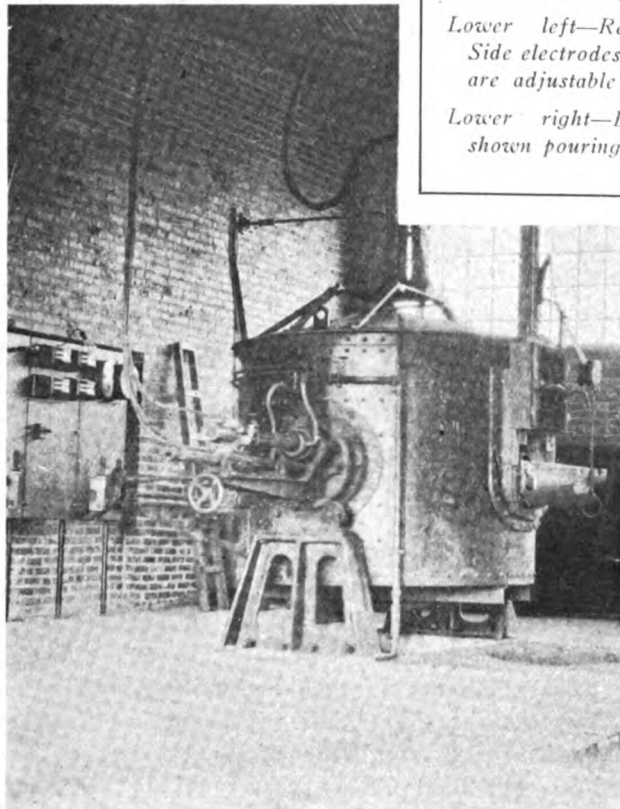
This furnace is arranged so that the power is introduced to the furnace through one, two or three main electrodes, the number dependent upon whether the furnace proper is to operate single, two or three-phase. The furnace is also provided with one auxiliary electrode and with cast steel grids which are imbedded in the hearth with a refractory facing.

The following are taken from operating records for a three-ton Booth-Hall furnace, used for the manufacture of steel castings at the plant of the West Michigan Steel Foundry Company. When these records were made the furnace had only been in operation two months. The lining is basic and the steel was used for the manufacture of naval gun carriages. Each heat was held for at least one-half hour while the laboratory checked the analysis and all castings were annealed.



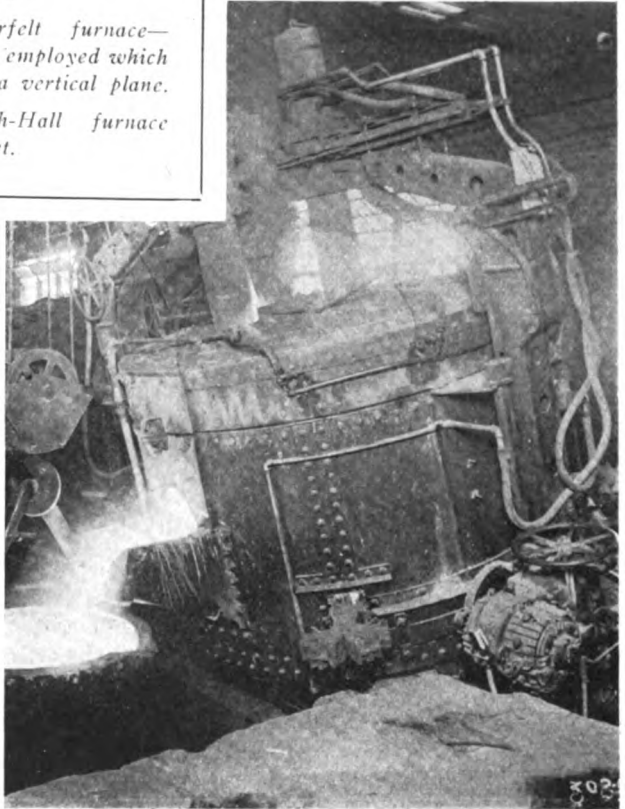
Upper left—Pittsburgh electric furnace—charging door is diametrically opposite to the spout, both doors being interchangeable.

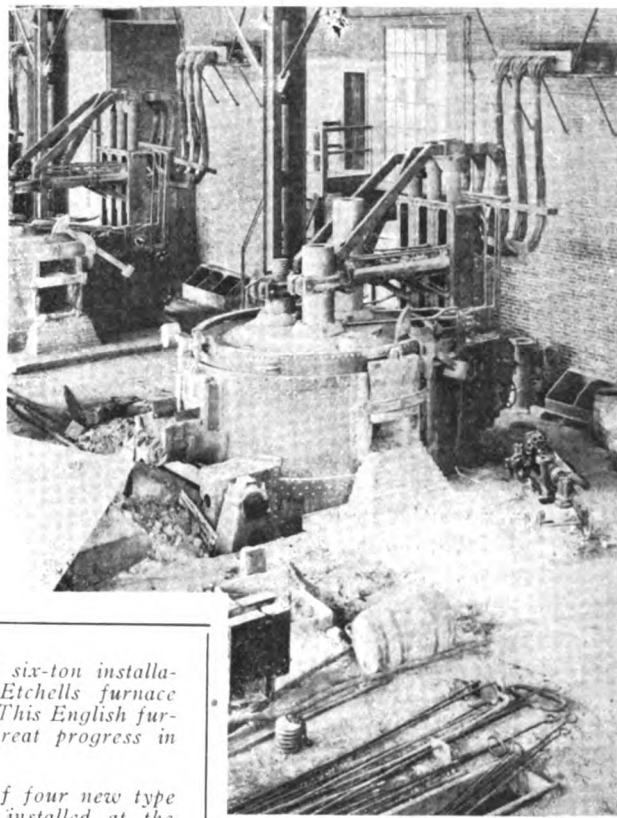
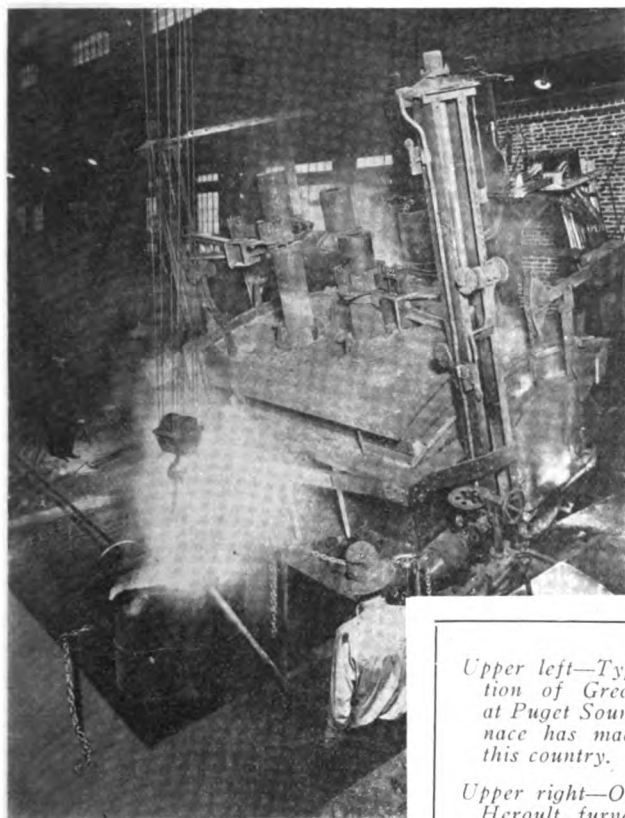
Upper right—Grontvall-Dixon furnace in operation. Higher voltage during melting period has been found advantageous.



Lower left—Rennerfelt furnace—Side electrodes are employed which are adjustable in a vertical plane.

Lower right—Booth-Hall furnace shown pouring heat.



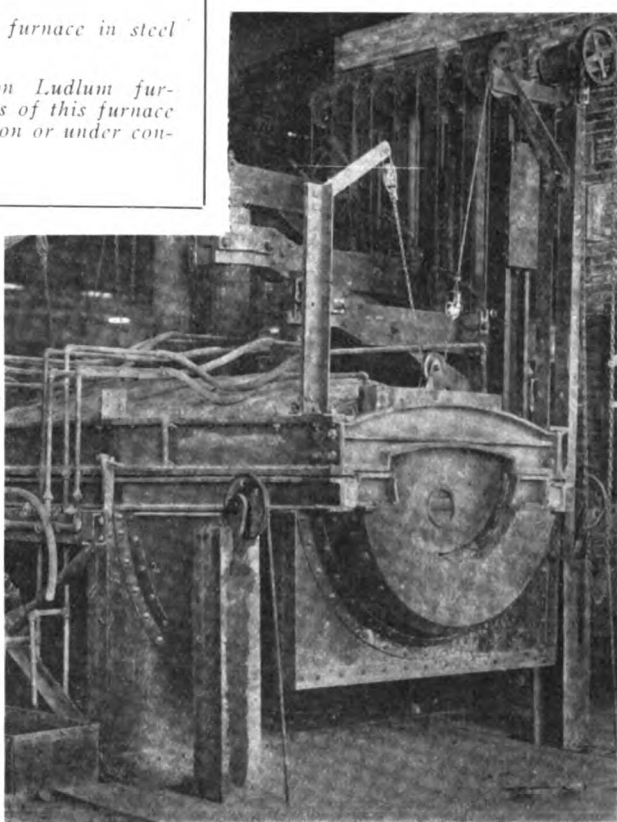


Upper left—Typical six-ton installation of Greaves-Etchells furnace at Puget Sound. This English furnace has made great progress in this country.

Upper right—One of four new type Heroult furnaces installed at the plant of the Hess Steel Corporation.

Lower left—Snyder furnace in steel foundry.

Lower right—Six-ton Ludlum furnace. Eleven units of this furnace are now in operation or under construction.



Records of West Michigan Furnace.

Month of September, 1918.

Steel poured, 340.5 tons.

Average power consumption, 641.7 kwh per ton.

Total hours operation, 360.

Total days operation, 24.

Average hours daily operation, 15.

Heats poured, 107.

Average charge, 3.18 tons per heat.

Average time per heat 3 1/3 hours.

Electrode consumption, 28.3 lbs. per ton of steel poured.

Average Analysis.		Average Physical Properties.	
Carbon	.30	Tensile strength, lbs..	63,040
Manganese	.61	Elastic limit, lbs.....	38,010
Sulphur	.043	Elongation	29.9%
Phosphorous	.038	Reduction in area.....	41.5%

Specifications call for 60,000 lbs. Tensile, elastic limit 45 per cent of tensile, 22 per cent elongation and 30 per cent yield point. Elastic limit above averages 60.3 per cent of tensile.

Ludlum Furnace.

The Ludlum furnace is a three-phase furnace of the direct heat arc type, used for the commercial production of tool steel and high speed steel, steel castings, low phosphorous pig iron, cast iron and ferro-alloys. A test recently made by engineers on a 10-ton Ludlum furnace producing chrome steel showed the duration of the heat to be 4 hours and 31 minutes, weight of charge, nine tons; electrical consumption per ton, 509 kw hours.

Rennerfelt Furnace.

The Rennerfelt furnace is now built in sizes ranging from 100 pounds up to six gross tons. All furnaces are of the cylindrical type with dome roof and solid bottom of fused-in material, which can be either basic or acid. The power input of this furnace is

adjusted by changing the distance between the side electrodes and the top electrode so that automatic control (used on sizes over 1,000 pounds) is employed only for the side electrodes. The side electrodes can be tilted downwards and are adjustable in a vertical plane. On all furnaces, the center line of the side electrodes is raised considerably higher than previously.

The furnace operates on the free burning arc principle and in addition can be operated as an arc resistance furnace.

Pittsburgh Furnace.

This furnace is manufactured in sizes of 200, 400, 800, 1,600 pounds 1½, 3, 6 and 12 tons capacity per heat. Sizes of 1,600 pounds and larger are all of the three-phase type. All furnaces are made with removable roofs with charging doors diametrically opposite spout doors, both doors being interchangeable. All three-phase Pittsburgh furnaces are built under the Moore patents with neutral connected to a bottom electrode, and so connected that an adjustable proportion of the power is returned through the furnace bottom to the neutral of the star connected secondary system on the transformer.

The normal melting down period of this furnace is one hour and 20 minutes. All polyphase furnaces of this type are equipped with automatic regulators and with motor driven charging machines operating charging boxes. All tilting motors, grears, screws, counterweights and connecting rods are eliminated from the pit underneath the furnace

Year Imposes Severe Test on Refractories

American Magnesite Deposits Developed—Silica Brick Industry Declines—Standardization of Shapes—Standard Tests for Slag, Load, Fusion, Volume Change and Chemical Analysis Formulated.

By **RAYMOND M. HOWE**, Industrial Fellow,
Mellon Institute of Industrial Research.

The field of "refractories" has attracted considerable attention during the year of 1918. Many problems developed, due to the war requirements of the nation, some of which were solved and others which were not. Other problems, not of a technical nature, have also influenced the industry to a marked degree.

The North American magnesite industry has enjoyed a prosperous year. As new deposits were developed, ores of superior quality were discovered, making it possible to reject the less desirable material. There is no question but that a great many of the North American deposits, now that they have been developed and their quality has been established,

will continue to be worked long after the importation of European magnesite begins.

What has been said of magnesite also holds for chrome ore to a lesser extent. The chief development in this field lies in the exploitation of the Cuban deposits, although these have not been worked up to the present time. Other deposits in the United States, previously abandoned, have been reopened temporarily during the past year.

The silica brick industry has not enjoyed the prosperity which might be expected. The total monthly capacity of nine-inch straights in 1917 was 29,250,000. This capacity has not been materially increased. On

the other hand, the production has actually decreased, the plants in 1917 having been able to work at 63.0 per cent capacity, while in 1918 the output was only 59.8 per cent of the total capacity. This represents a monthly production of 18,417,000 in 1917 and a monthly production of 17,510,000 in 1918.

This decrease has been due to several reasons, one of which was the shortage of labor which has made itself felt in this industry, especially since so many of the processes are manual and not mechanical. The shortage of fuel resulted in a decrease in production for a short time. During the influenza epidemic there was also a marked decrease in monthly production, this having fallen from 17,569,000 to 15,439,000 in four months. In view of these factors it is a remarkable fact that the demands for silica brick have been so well met.

The fireclay and firebrick industry has enjoyed a year of progress. The technical advances in this field, however, are naturally slow in developing. Even at the present high prices, firebrick sell for from one-half to three-quarters of a cent a pound. This small price does not permit extensive treatment of the raw materials, after mining, manufacturing and burning expenses have been deducted. The nearest approach to such practice lies in the application of physical tests for maintaining certain standards and for ascertaining the best uses for each clay as it occurs. Any advances therefore must deal with labor saving machinery for both mines and plants, more economical driers and kilns for drying and burning the ware and similar lines.

A great number of companies have installed more modern machinery during the past year. In a few cases older plants have been remodeled while in other cases the older units have been entirely replaced; in most cases an increased capacity has generally resulted.

The past year has also witnessed rapid strides in kiln construction. In most cases the older rectangular kilns have been replaced by round kilns of larger capacity and of lower fuel requirement for operation. In a few cases the companies have not been content with replacing old kilns by the newer round ones but have installed tunnel kilns. The use of this latter type of kiln has resulted in a curtailment of fuel consumption of about 50 per cent. The newest departure, however, lies in the application of regenerators to intermittent kilns. This has been done successfully in the west where oil has been used as the fuel. This practice is certainly to be commended when applied to the burning of magnesite brick, and may even be applicable to the silica brick industry.

There has also been a great demand for clays adaptable to special uses. Pot clays and crucible clays have been and are still in great demand. Fortunately there has been a great variety of clays for these

purposes from which to choose and several have been employed successfully. In some cases it has been necessary to blend clays.

There has been considerable unfavorable criticism directed toward American clays when used for making these articles. However, out of fairness to the producer of these clays, it may be pointed out that in many cases the American clays have not been given a fair and conclusive trial. In nearly every case when products made from these clays have not given satisfaction it has been found that there is a reason, other than the clay itself, responsible for the failure. Changing of mixes, grinds, time of drying and glass batches have all had their effect upon the quality of glass pots, while the harder usage of crucibles in the struggle for increased production has played its part in determining their number of successful heats.

Finally, the advances made in the field of specifications should not be overlooked. This field is divided into two parts, one dealing with standard sizes and shapes and the other with technical testing.

In the former field, the number of standard shapes and sizes has been materially decreased. By skillfully devising certain combinations of shapes, it has been possible to eliminate several shapes previously considered standard. It has also been possible to eliminate a certain number of shapes through coöperation with other industries. In some cases variations in size amounting to $\frac{1}{8}$ of an inch were encountered, most of which were unnecessary. There are still many opportunities for improvement, and consumers should not hesitate in coöperating in this field for they will benefit by the greater stocks of each size which will be available when fewer sizes are to be manufactured.

The American Society for Testing Materials has undertaken the task of specifying the way in which different tests on refractory materials should be made. Until recently there were not many standard tests which are conducted in standard ways. This society has been successful during the past year in formulating, through its committee, methods for conducting chemical analyses, slag tests, load tests, fusion tests and volume change tests, all of which are important.

A. V. Bleining has also contributed a set of definitions for different grades of refractories, which has been promulgated through the War Industries Board. Such definitions possess a certain marked value in that they equalize the many standards of quality throughout the country. This is in contrast to the former practice of judging firebrick by the process involved in their manufacture. It was a well-known fact that as a result of this practice many third grade refractories were superior (in refractoriness) to other first grade products.

Years Progress in Steel Casting Industry

Uniformity of Analysis of Steel—Electric Furnaces for High Grade Steel Castings—Oil in Cupola to Replace Part of Coke. Light Steel Castings Will Be Heat Treated to a Greater Extent.

By JOHN HOWE HALL,

Metallurgist, Taylor-Wharton Iron & Steel Co.

As was perhaps to be expected when the country was engaged in war, the improvements in steel foundry practice during the past year have been for the most part closely associated with the manufacture of castings for war purposes. This has been especially true of the army and navy, which have found it necessary to purchase castings in enormously increased amounts, and even to substitute castings for forgings in many cases in order to expedite production.

The steel foundries of the country were called upon to produce castings to meet very exacting physical and chemical specifications, and to conform to a rigor of inspection that would not be considered at all necessary for commercial work. Not only this, but to make the problem more difficult, the tonnage demanded was "every pound possible." The response of the industry to the demands made upon it has been a splendid example of patriotic endeavor.

The immediate result of the conditions outlined above has been that when a foundry found its castings subjected to criticism from the point of view of soundness, surface finish, etc., the men in charge have exerted themselves to perfect their molding and pouring practice, and the study they have given to this phase of their business has resulted in considerable improvement of the castings.

In the second place, foundries that made very few physical tests of their steel have been brought face to face with the fact that the steel they had always considered "good enough," was not good enough to satisfy rigid requirements. The result has been improvements in the uniformity of analysis of the steel, of steel-making practice, and more especially of the annealing or heat treating practice followed.

It is only fair to add to the foregoing that all the improvement has not been on one side. When the government officers and the foundrymen were brought together to consider what could be done to increase the output of high grade castings, the foundrymen were able to convince the officers that in a great many instances their specifications were too exacting and that a better all-around casting for the purposes desired could be secured by changing one or more items of the specifications. The result has undoubtedly been to improve, in most instances, the average quality of the castings for the purposes for which they were intended.

The use of the electric furnace in the manufacture of these high grade steel castings has been of the great-

est benefit to the industry and to the nation. With the electric furnace, castings of various sizes and weights have been produced without great difficulty, which were difficult if not well-nigh impossible to make with converter steel. The superiority of electric steel in its ability to withstand the tendency to form hot cracks has come most forcibly to the writer's attention in several foundries that formerly used the converter alone and have installed electric furnaces during the year just passed.

Several foundries using electric furnaces of small capacity have changed over from basic to acid lining of their furnaces and some furnaces have been started on acid lining. In many localities, it has been possible to obtain the low phosphorus (and sulphur) scrap necessary for acid practice at a low enough figure so that the use of the acid process was considerably more economical than the basic—due chiefly to the greater number of heats that can be made in a given time on an acid bottom. In spite of the fact that the acid steel is usually somewhat higher in sulphur than the basic, the acid electric furnace steel has proven itself very satisfactory in respect to freedom from hot cracks, so that the use of the acid process has resulted in an increased tonnage at a time when it was vitally important.

In an effort to improve the quality of converter castings, especially in the faces of increased sulphur content of the cupola when available (and consequently of the sulphur in converter castings) a process has been worked out by which oil is used in the cupola to replace part of the coke, with resulting decrease in the coke consumption and also of the sulphur content of the steel produced.

The ship-building program so strained the resources of the country for the manufacture of anchor chain that it was found advisable to turn to the steel casting industry for help. A concern that had already made a fine record in the manufacture of coupler knuckles undertook to solve this problem, and the results obtained should be a source of inspiration to the industry, as well as of pride in its past achievements. The methods adopted for casting the links were most ingenious. The steel used was made in the electric furnace, and was of a special composition that has grown greatly in favor in the past five years. To make matters even better, the chain was heat-treated in such a manner that it met successfully all the tests to which it was submitted and was found extremely satisfactory in every way.

1918 Accelerates Growth of Forging Field

**Large Reductions Not Favored—Water Cooled Forging Dies.
Mechanically Operated Heating and Drawing Furnace—Stevens
Regenerative Furnace for Uniform Heating of Ingots.**

By HENRY FREEMAN,
Allis-Chalmers Manufacturing Company.

In discussing the technical and mechanical development in the forging line in the year 1918, or say, during the period since the United States entered the war, it will be possible only to give a brief outline in the space allotted to this subject. It is not my intention to encroach on the preserves of the writer on "heating furnaces," but the subject of forging cannot be discussed without touching upon the heating of the ingot and the heat treatment of the forging as well as the actual forging operation. The most striking development that I see, is the realization, appreciation and finally the application of the technical knowledge developed during the past 10 years by our great metallurgists in their research work. A great deal of this information has been available for some years but the manufacturer has been slow to take advantage of it until compelled to do so by the stringent requirements of various branches of the United States government in their intensive program since entering the war.

When the government began reaching out for ships, guns, shells, etc., all requiring highest grade forgings, it soon became apparent there were not enough forging ingots being made to fill requirements; and all steel foundries of any size were called into the forging ingot business. Then and there trouble began for the forger, as the making of a forging ingot is a very different proposition than making steel castings, especially the casting of alloy steel ingots. For a time a large tonnage of inferior ingots was sold which brought a flood of protests from the forger. It was found that whenever the forging failed to meet the physical requirements, a micro photograph (unetched) would invariably show oxide and sulphide inclusions; in other words it was dirty steel.

Finally the parties interested assembled together, books on metallurgy were consulted, experiences and developments (held confidential up to this time) were freely exchanged with the net result of a better mixture in the open hearth furnaces, adoption of chilled cast ingots as against sand cast, improved shapes of ingot molds, and a more general use of the refractory hot top for the mold; so that today our ingot steel foundries are turning out a very superior steel forging ingot and equal to anything made in the world.

Having made a good ingot it is necessary to thor-

oughly preheat it to between 800° to 1,200° F. preferably in a covered furnace as against the open pit. (the more general acceptance of this method is a late development) next the preheated ingot is placed in the heating furnace. The latest development in this line is the regenerative furnace designed by Arthur L. Stevens, of Chicago, with the regenerative chambers in the back instead of the side as in the old open hearth type. The advantage of the Stevens furnace is that the heated gases are directed along the side of the ingot and deflected across the ingot at the door, then to the stack; while in the ordinary type of furnace the end of the ingot furthest in the furnace gets hot first and it must be "soaked" to bring the heat back to the door. In the Stevens furnace you can heat the ingot more quickly and more uniformly because the hot gases are directed to the part of the ingot which ordinarily takes longest to heat, i.e. at the door.

We have known an ingot in this type of furnace to be burnt off at the door before the inner end of the ingot was up to forging temperature. This type of furnace is made in all sizes and can be used with fuel oil or producer gas either raw or clean. The adoption of clean producer gas to forging furnaces may be mentioned as a very late development and worthy of more serious attention.

The next thing to be mentioned is the very general adoption of the steam intensifier type of hydraulic forging press of all sizes over the steam hammer; they turn out much better forgings. The heated ingot reaching the press the forge man has been taught recently, that he must not take deep "bites" (large reductions) into the ingot but must be careful to make a small reduction the length of the heated part; repeating until the piece is reduced to required size and shape. The forging stresses will then be as uniform as it is possible to make them in shaped forgings. Water cooled forging dies for the hydraulic press is another improvement developed in 1918.

The forging must now go to the heat treating shop, positively the most fascinating place in any works; if the steel is clean, what can the metallurgist not do with it—most anything? He is a wizard, and plays upon the temper of steel like a virtuoso on his violin, space forbids this angle being enlarged upon

here. Since Uncle Sam got into the war we are training men into the science of metallurgy by the thousand and it has become of such importance that the Sheffield University, England, has established a chair with its own faculty not connected with any other science for its teaching.

The improvements in heat treating shops are many. Car type furnaces being more generally used with improved methods for more thorough and uniform heating; by introduction of more reliable and fool proof pyrometers we are getting very good results.

Shells are being made all over the Eastern and Central states and a large number of automatic or semi-automatic furnaces have been devised for heating, oil hardening and tempering. Some shells are pushed endwise through tubes in the heating furnaces, but they are not heated uniformly, the bottom

being colder than the top; some are rolled through an inclined furnace, the shells being in contact with each other. Although this method is better than the tube method, it is also not entirely satisfactory. The Allis-Chalmers Manufacturing Company, in making 3-inch shells has developed an all-mechanically operated heating and drawing furnace, using a malleable link belt with motor drive, they have a chain on each side in a pocket connected across the furnace with flat bars bolted edgewise on 4 inch centers. Between these bars are placed three shells. The furnace being inclined the shells roll to the forward bar which acts as a shell retarder rather than a pusher, so that the only drag on the motor is the link on the steel slide in the pocket, this gives the shell a uniform time lapse both in heating and drawing. Both furnaces being in unison the output can be gauged to meet the nosing or any other operation.

By-Product Coke Oven Industry in 1918

By-product Coke Now Exceeds Bee-hive Production in the United States—Efficiency in Benzol Recovery—World's Largest Coke Plant Placed in Operation During Year at Clairton.

By C. J. RAMSBURG,

Vice President, Koppers Company.

No section of American industry can point with more pride to its record of progress and achievement in the year 1918 than the by-product coke oven industry. In the great war emergency, brought about by the demand for good coke and for the essential high explosive bases, and under this stimulus, an enormous plant capacity has been added. In 1917 there was produced approximately 54,000,000 tons of coke. In 1918, there will have been produced 59,000,000 tons. Practically the entire increase in production will be in by-product coke ovens. The increase in this class of coke will represent practically 24 per cent over 1917, and the year will close with almost 50 per cent of the entire coke production in by-product plants, the beehive operations having fallen off in their production during the last quarter over that anticipated in previous estimates.

On November 2, 1918, it was announced from Washington that the output of by-product coke had surpassed the beehive output and from that date the output would continue to exceed 50 per cent.

The year will be made memorable by many achievements. These may be enumerated in part as follows:

1. A marked increase in the efficiency of benzols in the recovery of benzols, particularly in the production of toluol.

The high point in this regard was made by the River Furnace Company of Cleveland, whose record

was most remarkable. During the entire year there was produced and delivered from that plant nearly .6 gallons of pure toluol per net ton of coal. The La-Belle Iron Works and the Youngstown Sheet & Tube Company were close competitors for the first place, closely followed by the Brier Hill Steel Company and Toledo Furnace Company. The remarkable feature of this increase in production was that it was accomplished with no loss in coke production. The benefit of this efficiency was in a supply of toluol for T.N.T. at a time when it was most needed and was an important contribution in winning the war.

2. The placing into operation of the world's largest coke plant at Clairton, Pa., for the United States Steel Corporation. This operation, involving the coking of straight high volatile coal of the Pittsburgh seam, was placed into operation about the middle of the year. This plant has suffered from shortage of coal, quality of coal and general labor conditions, and there still remains one battery of the 640 ovens, to be put into operation. It may be said, however, that the results indicate a high by-product yield and satisfactory coke.

3. A plant of 120 Koppers ovens was placed in operation at Pueblo, Colorado, for the Colorado Fuel and Iron Company. Several years ago coal from this district was thoroughly tested in a plant which at that time was considered as being the most modern plant in the world. After a lapse of several years, the coal was again tested in newer ovens and the knowledge accumulated in the interval applied to the process. It was shown that good coke could be made in a specially designed oven. The success of the new plant in making good coke is very marked and shows

the benefit of accumulated research work when properly applied, and that coals having the characteristics of Colorado coal can be successfully coked.

4. One of the most important events in coke oven work during the year has been up to this time, kept more or less undisclosed. This consisted in a large scale experiment on the coking of Illinois coal in the Koppers oven. Claims had been made for a certain type of oven, that by some inherent quality of its construction and operation that furnace coke could be made from Illinois coal and the inference was made that no other type of oven could do this. In order to decide this point, the plant of the Minnesota By-Product Coke Company at St. Paul, Minn., was secured for a test and the Bureau of Standards, acting under the instructions from the executive department of the government, conducted the experiment, making the matter conclusive by a blast furnace test on the coke produced. It may be said briefly, in anticipation of a report by the Bureau of Standards, that excellent coke was secured, which was afterwards used in the blast furnace with entirely satisfactory results.

During 1918, the following plants of Koppers ovens were placed in operation:

	Ovens
Colorado Fuel & Iron Co., Pueblo, Col.....	120
Minnesota By-Product Coke Company, St. Paul, Minn	65
American Steel & Wire Co., Cleveland, Ohio.....	180
National Tube Company, Lorain, Ohio.....	208
Bethlehem Steel Company, Steelton, Pa.....	60
Youngstown Sheet & Tube Co., Youngstown, Ohio....	102
Dominion Iron & Steel Co., Sydney, Nova Scotia....	60
Carnegie Steel Company, Clairton, Pa.....	576
Total	1,371

The following plants of Koppers ovens will go into operation the first two months of 1919:

	Ovens
Jones & Laughlin Steel Co., Hazelwood, Pittsburgh, Pa.	60
Carnegie Steel Company, Clairton, Pa.....	64
Bethlehem Steel Company, Sparrows Point, Md.....	60
Dominion Iron & Steel Co., Sydney, Nova Scotia.....	60
Providence Gas Company, Providence, R. I.....	40
Indiana Coke & Gas Co., Terre Haute, Ind.....	35
Seaboard By-Product Coke Company, Jersey City, N. J.	55
Total	374

The following plants of Koppers ovens will go into operation between the second and ninth months (exclusive) of 1919:

	Ovens
Jones & Laughlin Steel Co., Pittsburgh, Pa.....	240
Rainey-Wood Coke Company, Swedeland, Pa.....	110
Bethlehem Steel Company, Sparrows Point, Md.....	240
Carnegie Steel Company, Clairton, Pa.....	128
Algoma Steel Company, Sault Ste. Marie, Ont. rebuild- ing)	60
Total	778

The Semet-Solvay ovens put into run in 1918, were as follows:

	Ovens
The Portsmouth Solvay Coke Company, Portsmouth, O.	108
The Ironton Solvay Coke Company, Ironton, O.....	60
Chattanooga Coke & Gas Co., Chattanooga, Tenn.....	24
	192

Ovens under construction November 1:

	Ovens
Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.....	120
Lackawanna Steel Company, Lackawanna, N. Y.....	60
Domestic Coke Corporation, Newburgh, Ohio.....	60
By-Products Coke Corporation, Indiana Harbor, Ind.	120
Ford Motor Company, Detroit, Mich.....	120
Total	480

The ovens put into run by the Semet-Solvay Company represent a capacity of coal per annum of 1,380,000 tons, and an estimated coke production per annum of 995,000 tons.

The ovens under construction up to November 1, for this company, represent a capacity of coal per annum of 3,456,000 tons; estimated coke production per annum of 2,488,000 tons.

The Wilputte Coke Oven Corporation had completed or had under construction in the year 1918, the following by-product coke oven plants:

	Ovens
Steel Company of Canada, Ltd., Hamilton, Ont.....	80
Algoma Steel Corporation, Sault Ste. Marie, Ont.....	50
Citizens Gas Company, Indianapolis, Ind.....	40
Wisconsin Steel Works, S. Chicago, Ill.	88

Of the 80 Wilputte ovens building for the Steel

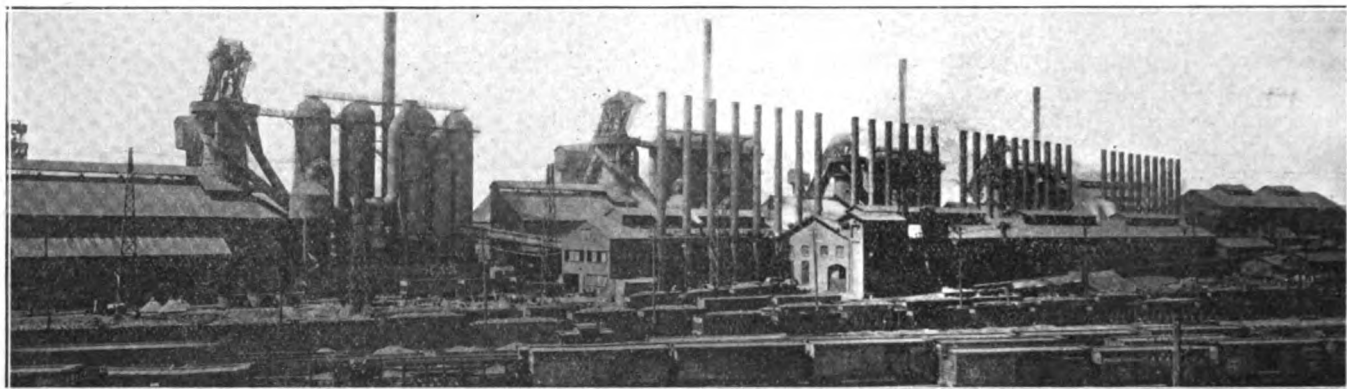
For the first time in the history of the by-product coke oven it has exceeded the output of the beehive oven in this country. This is indicative of the great strides made by this process. One of the most significant developments pointed out in this article by Mr. Ramsburg is the fact that Illinois coals have been successfully coked and that satisfactory furnace operation has resulted.

Company of Canada, one battery of 40 ovens is now in operation and the remaining 40 ovens were to be in operation by the middle of December, 1918. This plant will have a capacity of about 500,000 tons of coal per annum, and the estimated coke production (blast furnace) is about 325,000 tons per annum.

Twenty-five of the ovens for the Algoma Steel Corporation are now operating and the remaining 25 were to be in operation before the end of 1918. The entire plant will have a capacity of 310,000 tons of coal per annum and the coke production (furnace) is estimated at 202,000 tons per annum.

The 40 ovens at the plant of the Citizens Gas Company are practically completed. This battery of 40 ovens will have a capacity of about 250,000 tons of coal per annum, and the estimated coke production (furnace, foundry and domestic) is 175,000 tons per annum.

The 88 ovens for the Wisconsin Steel Works are now in the process of construction and will be put in operation by the middle of 1919.



1918 Blast Furnace Development Reviewed

Six New Furnace Plants Started During Year—Potash Recovery Studied—Tendency Toward Large Hearths, Steep and Low Boshes, High Inwall Batters and Moderate Thickness of Lining.

By F. H. WILCOX,
Secretary, Freyn, Brassert & Co.

Despite handicaps imposed during the past year upon rapid technical advancement in the blast furnace field, 1918 has seen interesting and significant developments.

The possibility of recovery of potash from fume carried in blast furnace gas has received publicity,

In the February issue of "The Blast Furnace and Steel Plant," a review of blast furnace blowing equipment will be published, pointing out the advantages, disadvantages and developments of turbo-blowers and reciprocating engines as brought out during the last year. Discussions by both manufacturers and operating officials will appear in connection with the article.

governmental attention and considerable quiet independent investigation as to the anticipated returns. Actual technical researches on recovery have progressed little further than the status at the first of the year, the results of precipitation tests then being encouraging. Apparently furnaces in the South and along the seaboard have sources of materials which promise to give excellent recovery. Those in the lake ore field using cokes and stone contiguous to their district have as a rule scarcely indicated paying recovery. The coming year will probably see the Cottrell Precipitator in operation at a blast furnace plant and data made available both as to the amount and the cost of potash recovery.

In the field of gas cleaning, work has progressed on a system of dry cleaning by filtration, to be put in

operation during the coming year. Wet cleaning has found increasing application, 15 furnaces having started work upon or started in operation wet gas scrubbers. Developments in the wet washing field comprise the introduction at Brier Hill of the Geesman Washer, and at the other plants, of the design of a vertical dryer, improvements in spray nozzles and washer betterments along the Brassert design.

In general, little attention has been paid to flue dust recovery. But two blast roasting machines have been started and these present little innovation in design or product. Interest has been particularly attracted toward the application of the Dorr Continuous Thickener to recovery of dust carried in gas scrubber waste water discharge. The results obtained at Chicago have been most satisfactory. Recovery of dust has been larger than anticipated and the clarification of water has surpassed results hitherto reached. The flue dust suspension has been concentrated to a 56 per cent sludge, which has been recharged. In connection with sintering or briquetting machines, a recovery of flue dust of 95 per cent has been indicated. Further installations are being made at three plants.

Advancement in stove design has not gone beyond the stage reached two years ago, represented by the Larimer four-pass stove and the Brassert two-pass stove. In both of these types gas economy and heat capacity has reached a very high point. The tendency during the past year at six new plants put in operation, has been to follow the two-pass design, using thin checker walls, small checker openings and dense hard burned stove brick. No innovations in

stove trimmings have been incorporated during the past year.

Six new furnace plants were started during 1918. Four have found description in the technical press. They incorporate the tendency toward large hearths, steep and low boshes, high inwall batters, and moderate thickness of lining, but have not gone as far in the first three directions as have certain remodeled furnaces. One 92-foot furnace has been remodeled to give a 20-foot 9-inch hearth, a 23-foot 6-inch bosh, and a 17-foot stockline. The possibility is that we have not yet reached the point where we have gone beyond the limit of beneficial changes or radical alteration in contour of lines. The lines of preference indicated in this year's construction and remodeling point to revolving distribution of stock, low tuyere area, three stove equipment, automatic mud guns, segmental hearth jackets with casting pipe cast in, a decreasing number of bosh cooling plates, increase in relative size of bell and decrease in angle of bell, use of improved burners at both stoves and boilers, wet scrubbers preceded by both ample dust catcher and whirler capacity, insulation of stoves and blast mains, cantilever type independently supported skip incline, concrete bins and gate type hot blast valves.

In mechanical equipment, centrifugal compressors are blowing three new furnaces, and gas blowers are on three new furnaces blown in this year, although reciprocating steam blowers are specified for two plants scheduled for next year. Alternating current has not been specified for the entire electrical furnace equipment of this or the coming years construction although the A. C. skip hoist has worked out satisfactorily and is specified for two furnaces to be blown in in 1919. There are several improvements completed and in course of completion looking toward automatic synchronizing of skip and large and small bell control. There is as yet no unanimity of thought or preference for size of boiler unit for blast furnace plants. Installations of 1250 hp gas fired boiler units are the largest in operation. Units of 2,300 hp are under consideration but plants put into operation during the past year have clung to a conservative size of unit not in excess of 800 hp. Steam pressure and superheat at furnace plants has reached 230 pounds pressure and 125° superheat.

Safety has on the whole held its attainments of the last two years, although rush repair and shutdown work has given rise to a regrettable number of accidents. Employment betterment and sociological types of mill activities have made, in a large number of plants, notable advancement. The eight-hour day basis for labor was established in one plant and established as a basing rate for pay at nearly all others.

Ferro-manganese practice in this country established at two plants some very notable records, especially in maintenance of grade, reduction of man-

ganese losses and maintenance of high heats and fuel economy. Noteworthy advancement was also made in the ferro-silicon field in the sustained production of high grade silico irons. There has been an increase in the manganese content for basic open hearth iron.

Furnace practice itself has not maintained its former advancement. This is due, first, to the use of notoriously inferior coke; and, second, to keeping furnaces in blast on badly deteriorated linings. Governmental agencies have endeavored to correct the former but the exigencies of demand have accentuated the latter. The action of the government in inspection of mine, coke oven, and coke wharf practice has proven most beneficial in securing betterment in cleanliness of coke and in some instances, in securing lower ash and more suitable physical qualities. In many cases by-product ovens remote from mines have had to use incorrect coal mixtures in the ovens and to stock same. The character of coke resulting has been such that the rate of driving in some instances has fallen off by 24 per cent and the fuel per ton has increased by 20 per cent. Sixteen per cent ash coke has been far from uncommon. One plant has actually continuously screened out at furnace coke bins 17 per cent in

The blast furnace operators of the country deserve to be commended upon the production of pig iron which they have secured in the face of numerous handicaps. Mr. Wilcox points out in this article that probably the greatest achievement in blast furnace work has been the resourcefulness and pertinacity of furnace men in combatting adverse conditions.

coke braze of coke invoiced to the furnace.

It is not going too far to say that the greatest achievement at blast furnaces during the past year has been evidenced in the resourcefulness and pertinacity of furnace men, operating and mechanical, officials and workmen, in getting production from materials that would have been rejected four years ago, and from furnace linings that logically belonged on the dump.

EDITOR'S NOTE—During recent months, 12 typical blast furnaces producing ferromanganese and spiegeleisen have been fully investigated by the Bureau of Mines. These 12 furnaces produce approximately 40 per cent of the total output of manganese alloys of the United States and offer a very fair cross-section of the industry as a whole.

The Year's Open Hearth Progress Reviewed

Great Effort Made to Secure Better Quality Steel—Basket Pouring, Steel Scrap With Solid Carbon Addition—Off Grades of Chromite Used As a Refractory Material.

By F. CRABTREE.

During 1918 the demand for the maximum possible output of steel was so urgent that it called for all the energy, thought and effort of every responsible man in the industry. This, in conjunction with the scarcity of skilled men and the indifference and inefficiency of labor, naturally tended to restrict efforts to established, well understood methods, and discouraged or prevented operators from experimenting with new ideas. So inquiries addressed to superintendents of open hearth plants met with the uniform reply that there were practically no new developments in open-hearth practice during the year.

Interpreted in the sense that no radically new methods of operating were disclosed, and no notable changes were made in the design of furnaces, this is true; but at the same time it is probably untrue that open hearth practice throughout the United States remained stationary. Probably never before during boom times has the strong demand for quality been coincident with such adverse working conditions, and the narrow range in variety of products, as have prevailed during the past year. Ordinarily, most plants have orders for a variety of grades of steel, and a heat that is outside the limits specified for one order can be rolled to fill another. This possibility has tended to cause carelessness on the part of open hearth operatives, which was troublesome when it became necessary to run almost exclusively on government orders; so it became necessary in many cases to hold furnacemen up to more accurate work.

Also there has been a growing impression that it might be profitable to devote more effort to the prevention of defects in the steel in order to save some of the expense of shipping, or excessive rejections. Within a period of about a week recently, three concerns in varied types of work considered the plan of developing definite, detailed standard methods of procedure, or definite standard requirements as to conditions, in the making of each particular product; this, of course to be followed by a systematic attempt to secure reasonable adherence to the accepted standards. There seems to be reason to think, therefore, that the most notable development in open hearth practice in 1918, was the greater effort to get better quality of product.

There is no doubt that many steel works officials have realized more clearly during 1918 than ever before that the making of good finished steel products is a much more difficult and complete problem than they had ever imagined. Take, for instance, the pro-

duction of large forging ingots for gun tubes or propeller shafts; how innocently and unsuspectingly did many steel makers offer to attempt to cast ingots of any desired size without knowing anything about the desirable shapes or proportions of such ingots, or without any conception of the fact that difficulties increase very rapidly with the increase in diameter. It is very probable that many of these makers could speak feelingly and heartily to our worthy secretary of the navy as to the difficulties he might have encountered in operating a government armor plate plant.

Another illustration of the efforts to secure better product was the great interest in, and extensive trial of the so-called basket pouring, or tun dish pouring. Widely known through its successful operation at the Brier Hill Steel Company's plant in 1917, and through the reports of its use in England, this method of reducing to a minimum certain surface defects in steel has been tried experimentally at least at a considerable number of plants. It may be of interest to note that a generation ago William Hainsworth, organizer of the Hainsworth Steel Company, recognized some of the advantages of the pouring basin and took out patents on several variations of the device, which, however, attained no commercial success.

Experience along the lines indicated above have emphasized more clearly than ever before that however important may be the details of making steel in the furnace, yet at least half, probably nearer three-fourths of the defects in steel products, are caused after the steel leaves the furnace.

Scarcity of pig iron was responsible for a slight variation in practice which, while it might not have been entirely unheard of, probably had never before been adopted regularly for any considerable tonnage, namely, the use of a charge containing no pig iron or cast iron. The percentage of pig iron in the charge has in the past varied very greatly from 100 per cent down to 20 per cent or less; and cases have been recorded in which cast iron scrap was used in place of new pig iron. But never before, perhaps, have plants run regularly on charges made up entirely of steel scrap, with solid carbon added to give the desired carbon content to the bath when melted down.

The scarcity and high price of ferromanganese, led to a much wider discussion of the advantages obtained by having at least 6 or 7 per cent of MnO in the open hearth slag toward the finish of the heat. This was demonstrated during the development of the duplexing process at Ensley, Ala., but given little

attention at the majority of steel works—possibly because so much of the basic pig iron contains enough, or nearly enough, manganese to yield the required amount in the slag. But regard for conservation of \$250 per ton ferromanganese lent new importance to the idea, and led to a much wider discussion of its bearing on the economy of operations and on the quality of steel produced.

The same condition led to the development of hitherto unsuspected possibilities in the use of comparatively low grades of ferromanganese and of spiegel, as well as to the vigorous attempt to interest steel makers in iron manganese-silicon alloys.

The latter again emphasized the lack of clear definite knowledge of what takes place when recarburizers are

added to steel.

Also during 1918 it was demonstrated that excellent results could be obtained by the judicious use of all grades of chromite as a refractory, particularly about the ports, and that care in the use of the material was of more importance than exact requirements as to the percentage of Cr_2O_3 present.

Necessity, in the guise of scarcity of new molds, led to the more extended patching of somewhat defective molds in order to permit their further use. A mixture composed mostly of graphite and flue dust is said to have given nearly 100 per cent increase in the life of some molds for the Carnegie Steel Company. This indicates a field of economy that may be worthy of further study.

Steel Foundry Industry Develops in 1918

**Improved Quality and Production of Larger Melting Units.
Rigid Foreign Requirements Great Training for American Manufacturers—Heat Treating of Steel Castings Receives Attention.**

By W. A. JANSSEN,

Operating Manager, Canadian Steel Foundries, Ltd.

In normal times, manufacturers are often given to being too self-satisfied with their own endeavors and progress; many even to the point of electing themselves as nestors of industry and setting up their practice and principles as standard. If these manufacturers are commercially successful, others soon rally to adopt their standards and methods, and a code of industrial standards is created. These then become the criterion of what can and what cannot be done; any deviation therefrom often being looked upon as quite absurd and uncalled for.

War with all its horrors and catastrophies seemed necessary to bring nations to a common and better understanding. Just so an industrial catastrophe, if you please, is necessary to bring industry to a better understanding and introspection and point out the vagaries of a self-satisfied performance. That industrial catastrophe produced by an unbalanced ratio of supply and demand has made us all study and try to utilize the raw materials at hand of off specification and to produce a finished product to what, even in normal times, might be called rigid specifications. The steel foundry industry has had to cope with this problem possibly more than any other line of activity and the American steel foundrymen are to be commended for their untiring efforts to serve with patriotic interest all allied and affiliated industry.

The metallurgical phase of the steel foundry industry has, without doubt, been the one which required the greatest consideration and wherein the greatest progress has been made. Almost all raw material has

been misfit or off specification, and in some cases heretofore obtainable materials were no longer available.

To those who are basic steel producers, the inability of obtaining Austrian magnesite was among one of the first problems to be met with. Many resorted to the old time practice of using dolomite for hearth material with all its comparative attendant unpleasanties. The refractory manufacturers, in their efforts to produce a synthetic substitute for Austrian magnesite, were confronted with the metallurgical problem of calcination and synthetically combining iron with American magnesite and dolomite. The results, for a time, were most unsatisfactory, but latterly a product was produced which bids fair to be as desirable as the Austrian magnesite and may be used in lieu thereof unless post war prices will permit the foreign product to enter this country at a lower price.

The inability of the blast furnaces to obtain sufficient and desirable coke, together with unsatisfactory and indifferent labor conditions resulted in the steel foundrymen being forced to use grades of pig iron, which, in normal times, would unquestionably have been rejected. This already seemingly unsatisfactory material, combined with a variable and almost equally unsatisfactory scrap of unknown and undesirable composition, made the problem of producing a desirable finished metal to rigid specifications, a most difficult problem. This metal market, unsatisfactory and undesirable, has undoubtedly been responsible for a great advance in open hearth furnace and other melting unit operations. The furnaces, instead of being

run according to thumb as were many in the past, have necessarily had to be placed under the control and jurisdiction of the laboratory and metallurgist, and it has meant a very close coöperation between the technical and the producing units of the steel industry which have never stood in their proper relationship.

Throughout the entire program of supplying of steel castings, the watchword has been production of quality material, and unfortunately this had to be met with the utilization of inferior melting stock. Aside from the improved and increased quality and production of the larger melting units, many manufacturers, in their efforts to serve and produce material of desired quality, did not hesitate to install electric furnaces.

A very large tonnage of steel castings produced have been for direct foreign consumption. It has always been well known and accepted, that demands and specifications for foreign requirements have been rigid, and possibly in the majority of cases needlessly so. European standards of service, together with their low labor and material costs as compared with American markets and their paramount thought of quality rather than quantity production, make their demands upon American manufacturers most exacting. In the reports of European investigating committees which have visited American plants, practically none of them criticized the quality of our material, but many have much to say concerning the finish, and our laxity and our failure to adhere as closely to dimensions as they do in Europe. The European demands have been a great training school for American manufacturers, inasmuch as they have been able to maintain both a quantity standard and meet quality specifications, both for material and finish, all of which should augur for a better product to the American consumer after the war.

The specifications of United States Army and Navy always have been looked upon by the average American steel casting producer with a feeling of awe, and many have been hesitant and others have absolutely refused to accept the business because of the rigidity of specifications. Even when the demands of war were most urgent and even upon the eve of America entering into the war, this same feeling continued to exist in the minds of many steel foundrymen. The inability of the United States government to obtain castings, as also that of many of their contractors, became most critical and resolved itself into the ordnance division calling together representative committees of the foundry industry represented by the Steel Foundry Society and the American Foundrymen's Association, for the purpose of a discussion of this all-important phase of specification. The entire conference was imbued with but one thought and motive—that of serving the government—and all for a common good, with the result that the specifications for

phosphorus and sulphur, together with the physical specifications for the three grades of steel, were changed to meet the demands and requirements of both customer and producer. Many of the old-time theories as to the deleterious effects of phosphorus and sulphur have had to be discounted for an equally serviceable casting as compared with the prior limits of these metalloids. It is quite true that these increased limits possibly caused the foundrymen manufacturing difficulties, but in many cases this was the open sesame for the bringing together of the foundryman, engineer and designer of these castings, with a view of changing the design so as to offset attendant shrinkage and crack difficulties.

Notwithstanding all that has been written and all that has been said about the annealing of steel castings, the lack of understanding as to what constituted good annealing seemed to cause the steel foundrymen more trouble than anything else. In addition to lack of understanding of annealing, the heat treating of castings in order to meet the physical specifications, was also a new metallurgical phase, which, heretofore, had possibly received little or no attention on the part of the foundrymen.

With this bringing together of the manufacturer and consumer, the inspection of castings, instead of being based on the principle of promiscuous rejection, was conducted along the lines of intelligent acceptance, which, after all, is the fundamental purpose of inspection.

Much more might be said, but suffice to say that the demands of war, with all its problems of serving, the manufacturing industry has been taught lessons by which it has profited and which should be of mutual and inestimable value to manufacturer and consumer in the times of peace which are to come.

Editor's Note—The steel foundry industry has made considerable strides on the Pacific coast and it is interesting to note the remarks made by J. D. Fenstermacher before the American Foundrymen's Association: "Manufacturers of steel castings are confronted with a necessity for three vital things—scrap, sand and experienced mechanics. The question of scrap is being given serious consideration in the far West, not only by steel foundrymen but by the rolling mills which consume more of this material than the foundries. The present demand for scrap exceeds the production. Pig iron is being produced in very small quantities on the Pacific coast and this production is not sufficient to offset the rapidly diminishing quantity of scrap. However steps are being taken to produce suitable pig iron locally on a large scale. This will be the solution of this vital question. California has considerable ore deposits, but coking coal has always been a drawback. Nevertheless, there are favorable indications as to the nearby source for the quantity production of suitable coke."

Electric Steel Mill Drive Developments

Standardization Given Much Consideration—Flexibility of Mill Operation With Electric Drives Permitted Variation in Mill Schedule—Tendency Toward Central Station and 60-Cycle Apparatus.

By BRENT WILEY.

The motor operated steel mill today is practically an accepted standard type of driving unit. Its use has been almost universal during the last several years, and over a period of 12 years totals more than 550 units aggregating approximately 850,000 hp. All classes of steel mills are included in the list and a review of the results that have been accomplished by this improved type of drive gives emphasis to the many general advantages of electrification.

The electrical manufacturers have given much attention to the study and analysis of steel mill conditions and requirements and have developed suitable apparatus for all classes of steel mill work, including the auxiliary machines and main rolls. The success of the modern mill, however, is the result of the combined efforts of the steel companies, the mill builder and the

and conditions as definitely as possible and obtain a practical basis for estimating.

Much credit is due the Association of Iron and Steel Electrical Engineers for the rapid development of electric drive for steel mills and its extensive application. The organization which is composed of more than 300 steel mill electrical engineers and several hundred associate members interested in steel mill activities in an indirect way, have presented more than 200 papers on subjects pertaining to electrical apparatus and use of electricity in the iron and steel industry and are devoting much attention

to the subjects of standardization, technical analysis of field data, and other broad matters which will advance the art of mill electrification.

The broad and varied experiences obtained in motor-operated mills during the war period of the last three years has demonstrated the several advantages of electric drive with unusual emphasis. Many mills were

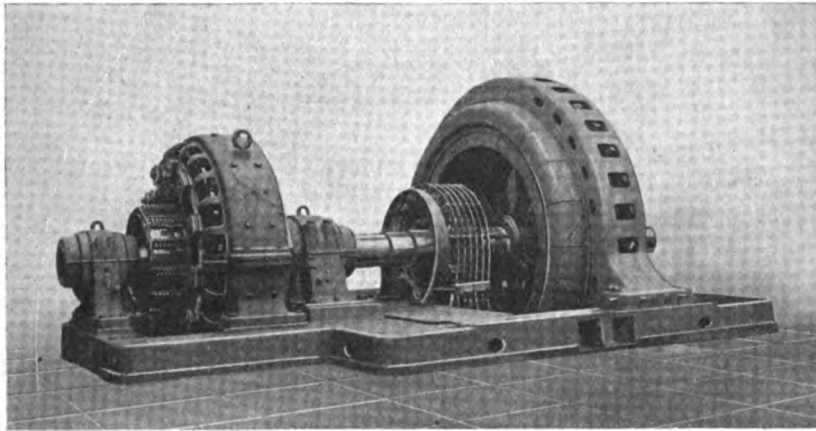


Fig. 1—Adjustable speed alternating-current motor, direct connected to 18-inch merchant mill.

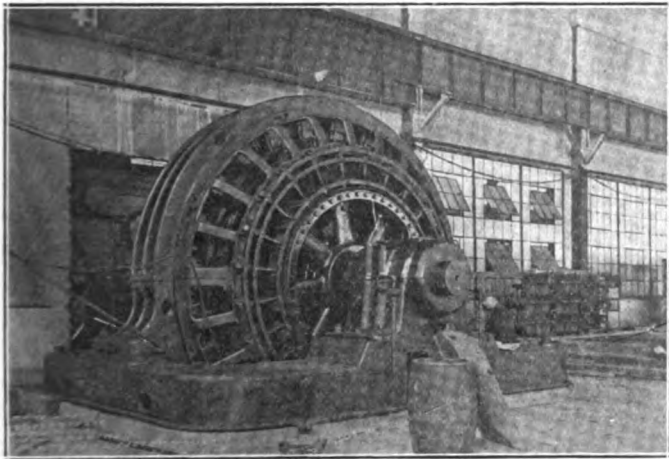


Fig. 2—Reversing motor unit—30-inch universal plate mill Mark Manufacturing Company.

electrical manufacturer. Such points as practical limits of draft, roll speed and temperatures of rolling have a direct bearing on the mill output and power requirements, and before considering such matters as motor capacity it is extremely important to establish the rolling schedule

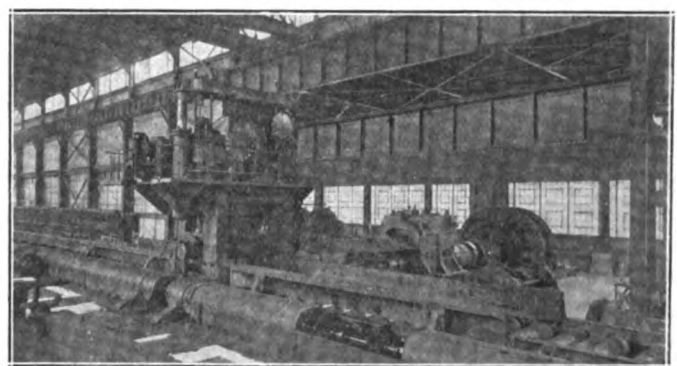


Fig. 3.—General view of 30-inch universal mill at Mark Manufacturing Company.

planned, built and put in operation to meet extreme emergency demands for various war steel products. Time was an important factor and electric drive was a favorable means of facilitating the construction of the plant. Many items which are necessary with the steam

engine driven-driven mill are eliminated, including boiler plant and extra buildings. While in some cases it was necessary to enlarge the plant electric station, this work was not a large item when the time and expense involved was distributed over the several mills usually included in the new addition. In many cases central station power was used which eliminated the power generating problem entirely. It was possible to obtain the electrical equipment within a period that was consistent with delivery of mill machinery.

The flexibility of mill operation with electric drive has permitted a wide range of product and a variation in mill schedule which has materially assisted in rolling the most advantageous sections and has been a material factor in increasing the tonnage. In three-high mills the adjustable speed alternating current motor drive gives a wide range of speed with a variation ranging in many cases of 40 per cent. The equipment can be designed for either constant horsepower or constant torque requirements, but a majority of mills require approximately a constant horsepower proposition.

It is consistent with good practice to include in the motor design special characteristics to best suit the particular mill requirements, as this can be done with but little sacrifice of motor efficiency, or mechanical features. In one case a heavy plate mill was installed with a direct connected slow speed motor without flywheel included, which meant a wheel of exceptional weight. With the largest practical flywheel capacity that could be utilized the peak loads were estimated to be quite large and it was decided to eliminate the flywheel, thereby reducing the all-day friction losses and provide suitable characteristics in the motor to meet the demands of the high peak loads. A motor having a pull out torque of four times the normal load torque was installed. The size of the motor (7,500 hp) and load requirements made a gear drive impractical.

A wide latitude in mill layout is permitted by the use of herringbone gears which permits the selection of speed of driving unit through a wide range. The development of suitable reduction gears has reached a most satisfactory state within the last few years and today a large majority of mills, the average of which requires about 1,500 hp unit, are installed with moderate speed

motors and gear reduction. This is favorable toward the idea of standardization as it keeps the large units within a more limited speed range. The motor has better characteristics, including efficiency and power factor and the desired margin of mechanical safety factors can be secured to a more positive degree, which is one of the main advantages of standardization. The first cost of the complete drive, including motor and gears is less as a rule and the efficiency of operation

is improved as compared with direct connected drives for many applications.

One of the principal developments of recent years has been the reversing mill motor equipment. Its success has been very marked and its adoption is quite general today. A number of mills of recent design include a reversing roughing stand and tandem arrangement of mill which gives the plant greater flexibility of size of product and increases the tonnage with a decrease in power requirements. Plate mills, strip mills and structural mills are some of those in the list. Unlike the steam drive which calls for unusual steam supply for a reversing

equipment, the reversing motor drive acts as an equalizer for the three-high, continuously operated mills as the

power taken from the supply line is quite uniform for the former, and intermittent with high peak loads for the latter type of mill.

The question of electric power supply for large motor drives has received broader power consideration during the last few years. Many plants have found it an advantage to analyze their requirements and future improvements

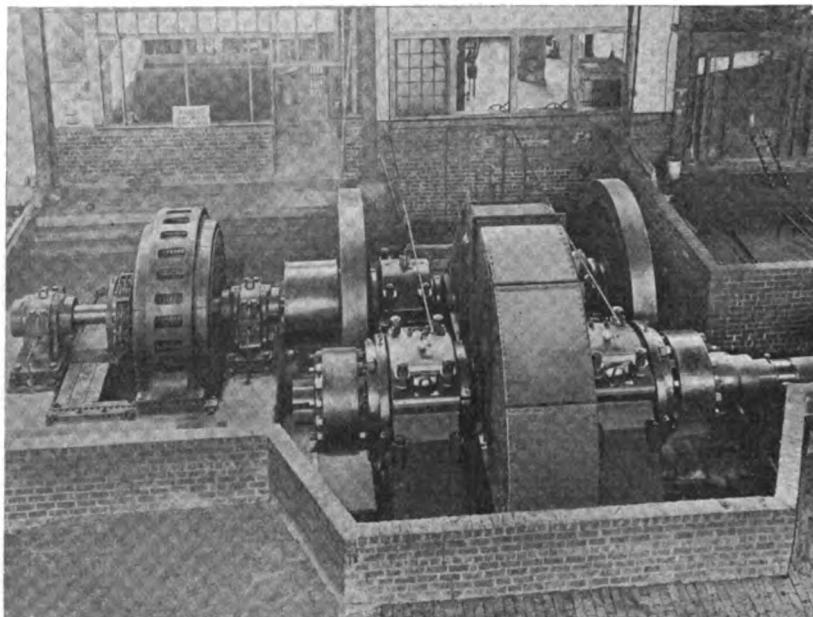


Fig. 4—1,500 hp alternating-current motor connected to sheet mill by gear drive at Canton Sheet Steel Company. Note location and arrangement of flywheel in pinion shaft.

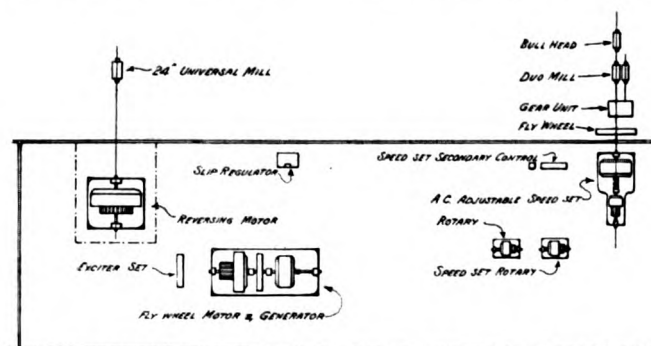


Fig. 5.—General arrangement of mill which includes a reversing roughing mill equipment at Brier Hill Steel Company.

from a complete plant standpoint and thus give each individual mill proposition the benefit of its real relation to the plant proper and thus properly distribute general charges and enables the advantages of the motor drive to be capitalized as a part of general scheme of improvement. Remarkable possibilities have been shown on this basis, but when the individual mills are analyzed as segregated propositions the summary of the advantages of motor drive do not establish the true over all plant efficiency. One of the noteworthy features of recent practice is the selection of large size turbine units and a more liberal policy to provide for general plant electrification. This tends to improve the efficiency of power production as the water rate of the large size turbines is materially better than for the size of units formerly se-

lected for mill use. During the past year turbines ranging from 15,000 to 20,000 kw have been selected for steel mills, as compared with the 5,000 kw turbine which is about the average of the units formerly installed.

A more common use of central station power has been adopted during the war period in particular. It has been a factor in facilitating installations and also offers many advantages of reduction of first cost of plant, reduced cost of operation and permits of greater flexibility of plant layout for future improvements. More than 50 per cent of the motor equipments installed during the last two years use central station power and more than 60 per cent are 60-cycle units. The tendency toward the adoption of 60-cycle apparatus as a standard is very marked.

Modern G. E. Electric Steel Mill Drives

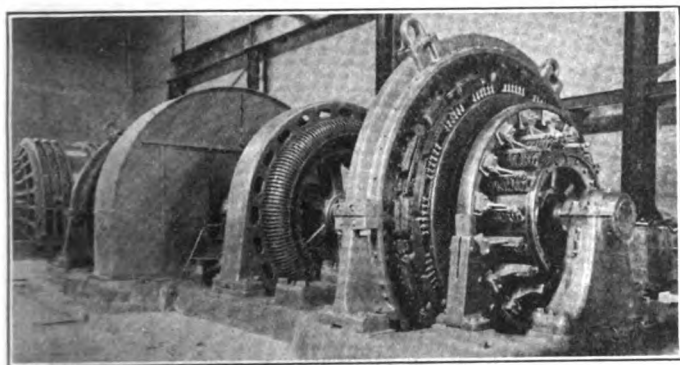
Novel Electric Drive Operating 1,200-Ton Hydraulic Bloom Shear With Rapid Acceleration and Retardation and Distance Control — Thirty-six-inch Reversing Blooming Mill Motor.

A novel electric drive is now being built for operating a 1,200-ton hydraulic bloom shear. This type of shear ordinarily derives its power from a steam driven hydraulic intensifier. Since, however, in the Fairfield works of the Tennessee Coal, Iron & Railroad Co., no high pressure steam would be available except from a boiler plant maintained especially for this shear, it was decided to use electric power. A rolling mill type reversing direct current motor having a continuous capacity of 700 hp at 86 rpm and good for momentary

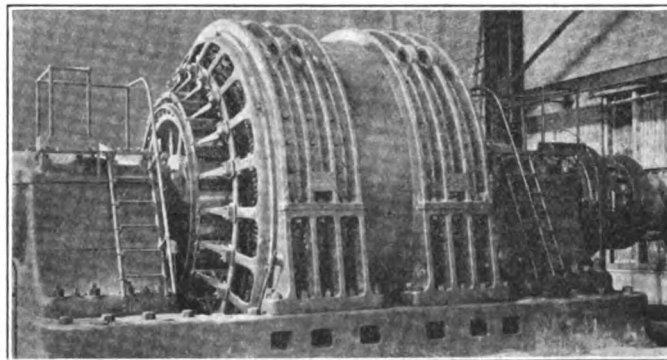
seconds. The control system provides also "distance control." When the shear operator throws his lever a certain distance in either direction the shear will move through a proportional distance and will stop automatically at a position which corresponds to the operator's lever.

It is interesting to note that the maximum travel of the intensifier ram requires a total of only approximately $3\frac{1}{2}$ revolutions of the motor armature.

The electrical equipment driving the 36-inch re-



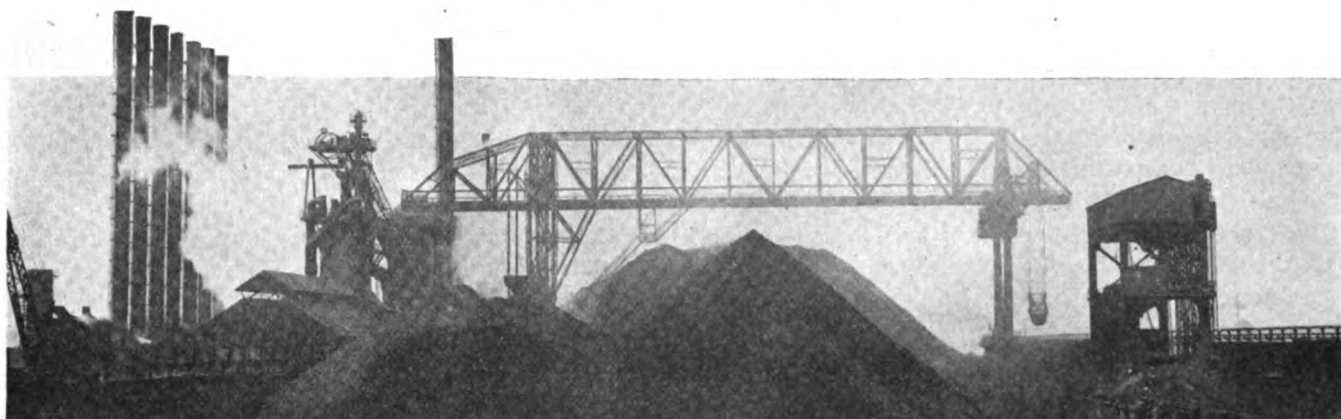
Motor room of 36 inch reversing blooming mill.



Reversing blooming mill motor.

loads of 350 per cent is coupled to a pinion meshing with a rack which drives the intensifier plunger forward and reverse. Power is supplied by a flywheel motor-generator set with the customary liquid slip regulator for equalization of the A. C. input. The control is a special type Ward-Leonard. Extremely rapid acceleration and retardation must be provided, as under the worst conditions of operation the motor is required to accelerate to full speed, run for about $\frac{1}{2}$ second at full speed, and retard to rest, all in $2\frac{1}{2}$

versing blooming mill at the plant of the Trumbull Steel Company at Warren, Ohio, was put in operation in June and has been in successful operation since that time. This equipment has a double unit main roll motor having a normal continuous capacity of 5,000 hp and a momentary torque capacity of 2,000,000 pounds at one foot radius. Power for this reversing motor is derived from a flywheel motor-generator set, consisting of two 2,000 kw generators, one 3,000 hp induction motor and one 50-ton flywheel.



Modern 500 Ton Brier Hill Blast Furnace

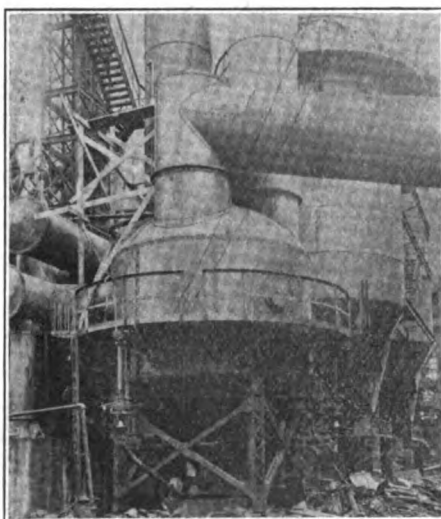
Furnace Built and Placed in Operation Without Shutting Down Previous Units — Description of New Stack and Auxiliary Equipment—New Geesman Gas Washer—Section of Furnace.

On September 21, 1918, the Brier Hill Steel Company, at Youngstown, Ohio, "blew in" their new No. 3, 500-ton stack. The furnace is of modern design in every particular. The foundation, which rests on bed rock, consists of a concrete block 42 feet in diameter, and over 16 feet thick. Several courses of brick on top of this concrete block support the heavy cast-iron base plate, 33 feet in diameter, on which rest six cast-iron columns, 30 inches in diameter. These columns support a mantel, 30 feet 6 inches in diameter, composed of heavy steel angles and plates. The shell proper of the furnace stack, rests on this mantel. It is over 30 feet in diameter at the bottom and tapers to suit the lines of the furnace.

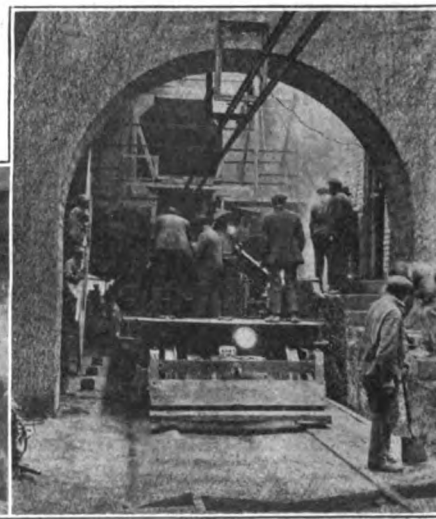
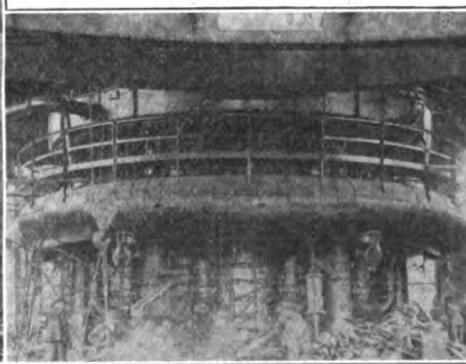
The hearth, 17 feet in diameter, is enclosed by a cast-steel jacket 5 inches thick, over 10 feet high, and 26 feet in diameter, held in place with steel bands and cooled by cast-iron cooling plates laid against the inside surface. The tuyere jacket is made of steel

plate $1\frac{1}{4}$ inches thick, with holes cut in it for inserting copper bosh plates and 12 tuyeres. There are 12 rows of bosh plates extending just below a mantel. A combination water supply and waste trough, supported at the level of the mantel, supplies cooling water to the bosh and collects the discharge from it. This trough has two main inlet and two main discharge connections. All feed and discharge pipes are readily accessible from a platform built on the bustle pipe, with handrail and stairs to the furnace floor. The bustle pipe supplies highly heated air to the tuyeres. It is 40 feet in diameter and is hung from the furnace columns by heavy rods. The mud gun crane and holding device, furnished by Edgar Brosius Company allows the tapping hole to be stopped without taking the wind off the furnace. It is operated at a distance from the tapping hole, thus doing away with any chances of burning the operator.

The cast house is 60 feet wide by 150 feet long by



The dust catcher is 24 ft. in diameter with dome top and explosion valve. Stock is mechanically discharged from bins with roller gates into heavy cars mounted on scales.

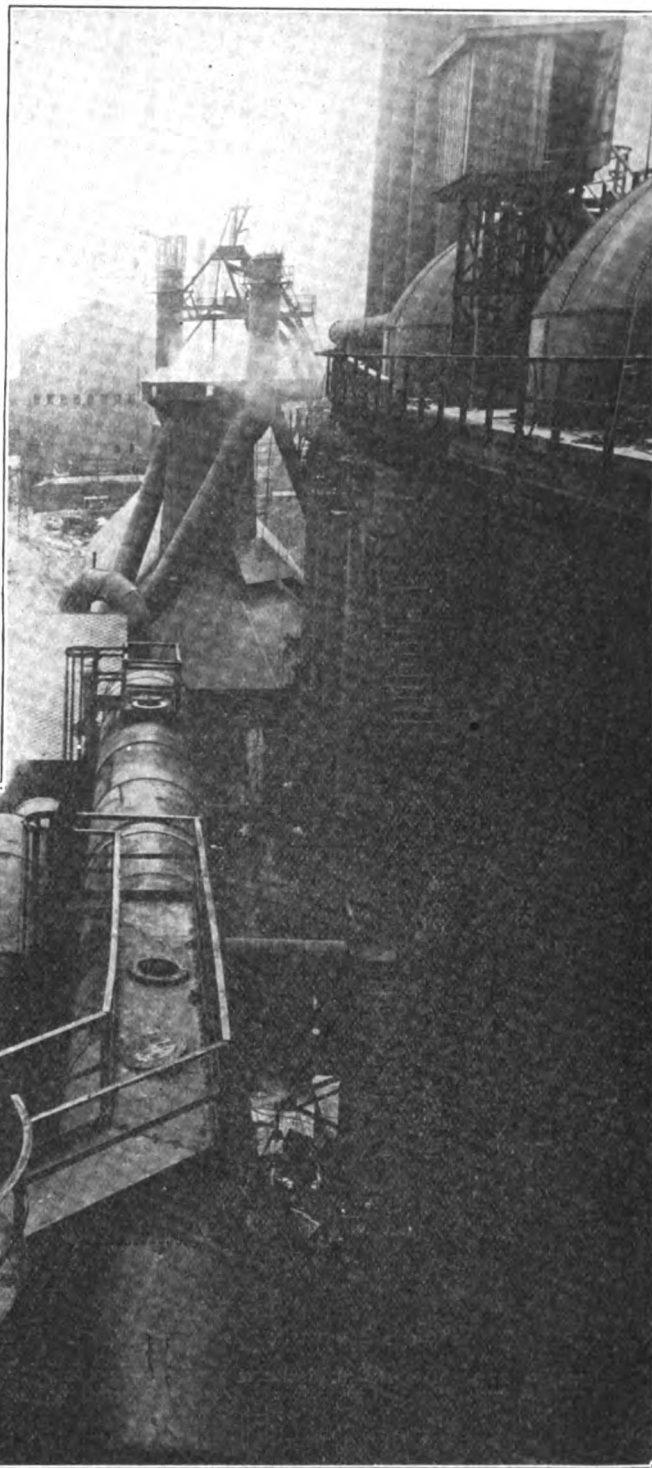


30 feet high, with a steep roof made of steel plates $\frac{1}{4}$ -inch thick, and with sides of No. 18 gauge corrugated steel sheets. It contains a 10-ton overhead crane. No part of the house connects to the furnace shell. Extra large ventilators take away any gases that might otherwise accumulate. All enclosing walls are of concrete with a rigid hand railing their entire length. The track for receiving the hot metal has a length inside of the building sufficient for a train of four inches with a capacity of 45 tons each. The furnace top is of the well known McKee revolving type with double skip. In this top the stock is discharged from skip car to a small bell which is automatically revolved by an electric motor so that each "round" enters the furnace at successive 60 degree points of the circumference.

Gas System.

The gas is conducted from the top of the furnace through four down-comer outlets of low type, with deflector plates, to prevent the escape of coke and heavy flue dirt. Above one of these outlets is an explosion or bleeder valve. The four down-comer outlets combine into two main pipes which enter the dust catcher tangentially. The dust catcher, 24 feet in diameter, has a dome top on which is mounted an explosion valve, and a cone bottom, from which the flue dust can be discharged, either into a railroad car or into the flue dirt trench. From the dust catcher, the gas passes to a steel plate gas washer, 18 feet in diameter by 40 feet high, of a combination spray and impact type, entering at the cone-shaped bottom and leaving at the cone-shaped top, from which

it is conducted to the bottom of the gas dryer, 18 feet in diameter by 27 feet high. The gas leaves the top of this dryer and passes to a special water sealed gas valve of new design and from there to the boilers and stoves. All the water from the openings of gas washer, dryer and valve is sewered into a large flue dust pit or sedimentation basin, which removes all trace of solid matter before the water is discharged into the river.



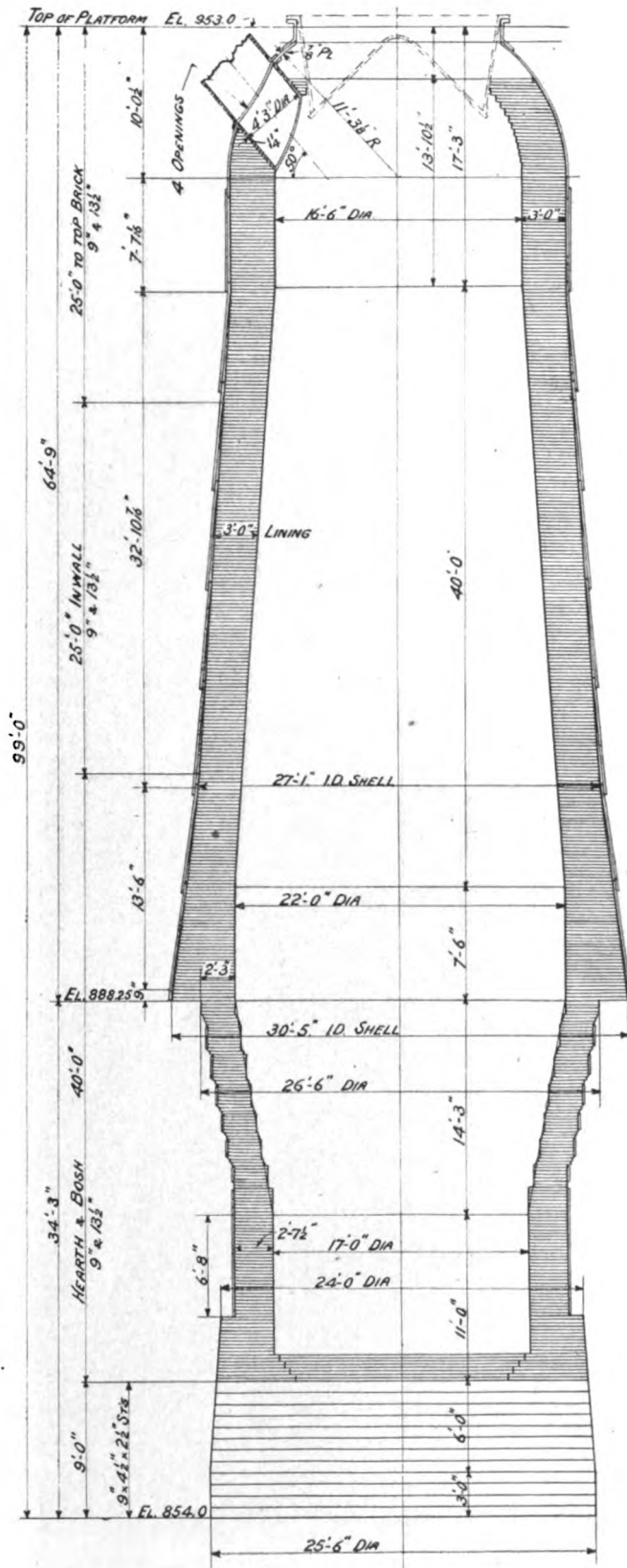
Gas cleaning apparatus and stoves. A one-ton electric elevator provides convenient means for the workmen to reach the top and make inspections.

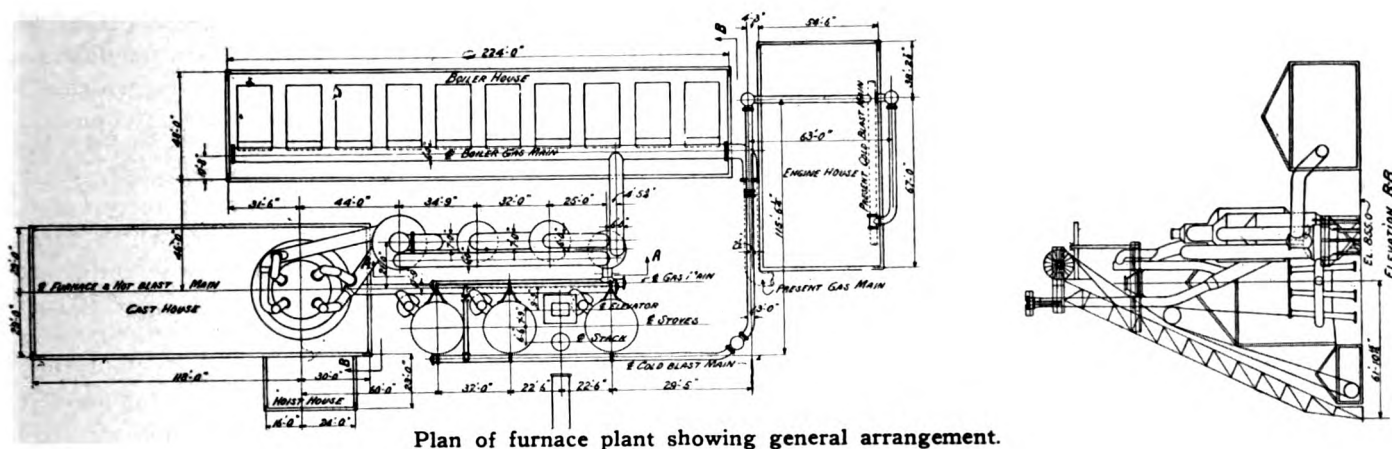
vided with one gas burner, one cold blast connection, one hot blast valve, with special device for changing valves and seats, and two chimney valves, which take the waste gases to the underground flue connecting with a centrally located brick lined stack 200 feet high. The blowoff pipe, which is used for relieving the pressure inside the stove before the gas is turned on, connects into the chimney flue, thus doing away with the noise usually accompanying this operation. The stove floor is 7 feet above yard level, and the chimney flue is built in this foundation above yard level so that it can never be flooded with water. There is a spacious platform at the top of the stoves connecting to the furnace stack with a bridge. A one-ton electric elevator from the stove floor to top platform provides convenient means for the workmen to reach the top and make inspections. A stairway around the elevator shaft can be used in case of accident to the elevator.

The hoist house, a lean-to between the skip bridge and cast house, is 26 feet wide by 40 feet long with a roof of ¼-inch thick steel plates, the under side of which is ceiled with tongue and groove wood sheathing. The walls are of brick, and special attention has been paid to illumination. In it is housed the Otis double drum skip hoist, driven by 200 hp 220 volt, direct current motor. The hoist is started by an operator, and automatically accelerates, slows down and stops. In the hoist house also are placed the panels by which the revolving top is automatically controlled from the skip motor.

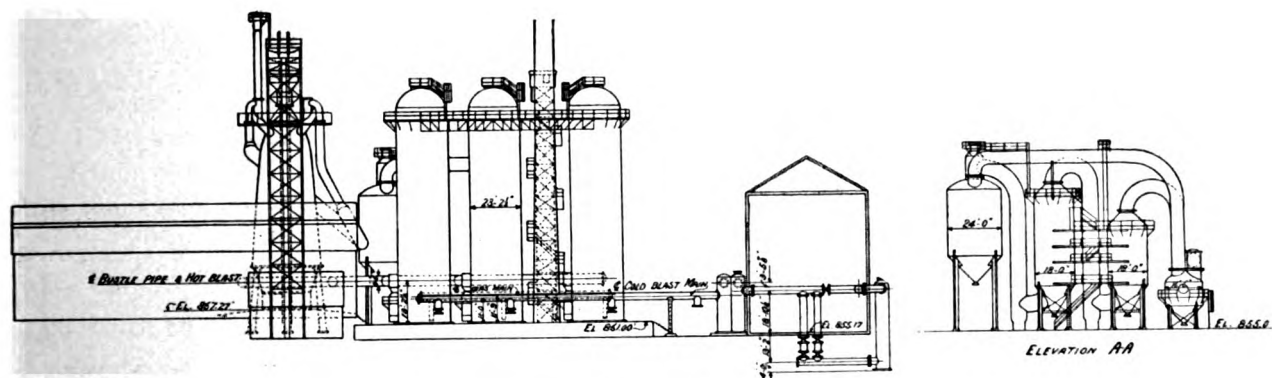
Blast is furnished by two Ingersoll-Rand Company turbo blowers with capacity of 50,000 cubic feet per minute, each, equipped with barometric condensers, vacuum, and circulating pumps, furnished by the same company. The turbo blowers are so well balanced that they are not bolted to the foundation and show no perceptible vibration when running at 3,000 revolutions per minute. These two machines, together with an old Tod engine, form the blowing equipment for both Grace furnace and the new stack. A novel hood surrounded by heavy copper screen and placed on air intake pipe above the engine house roof, keeps foreign matter out of the air intake. It was designed to cut down the velocity head of the incoming air. It has a walk around it, readily reached from the ground by a safety ladder.

A heavy waterproof concrete tunnel under the Pennsylvania, B. & O. and Erie tracks, connects the pump house on the river bank with the basement of

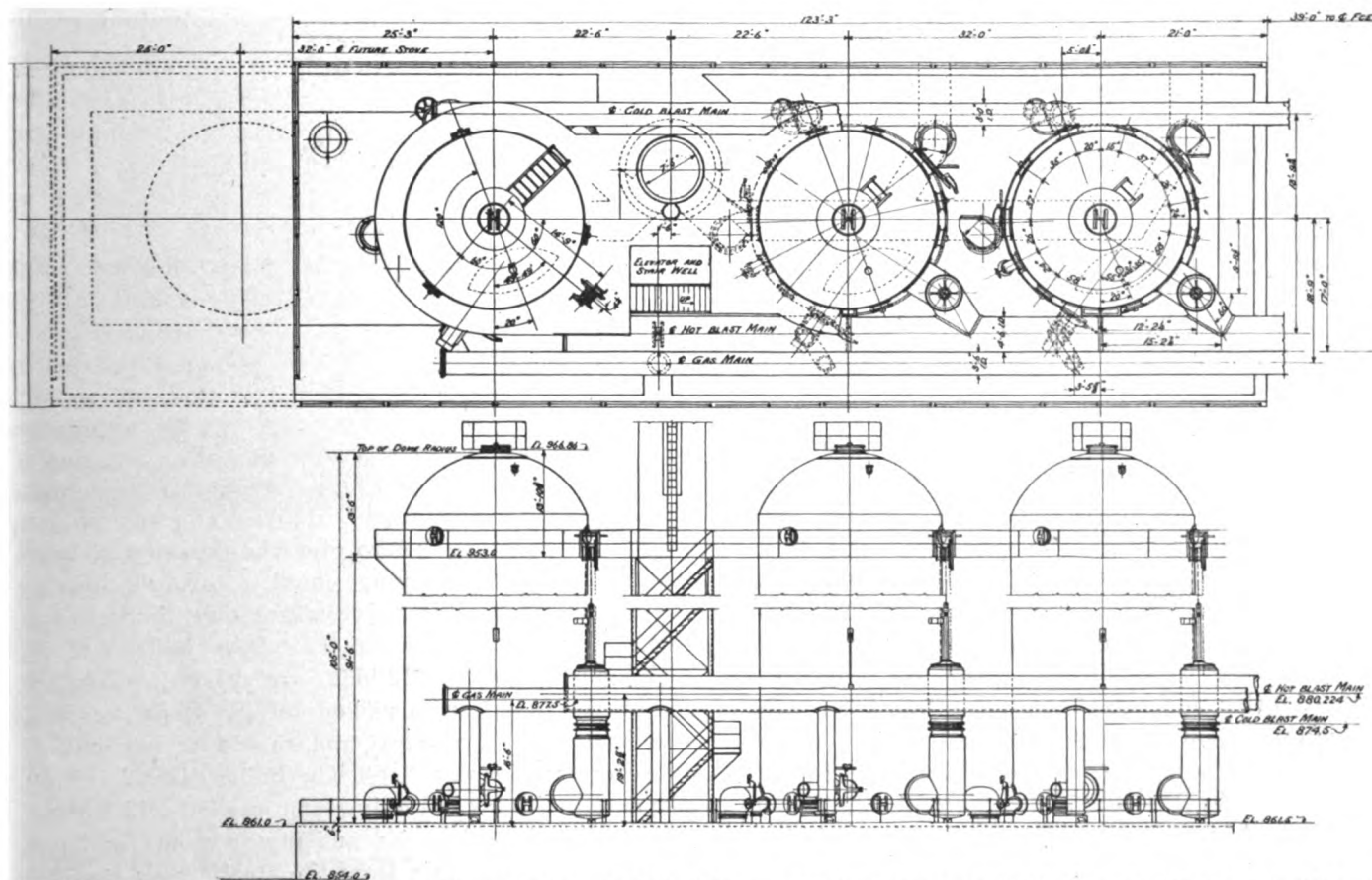




Plan of furnace plant showing general arrangement.



Elevation of furnace plant.

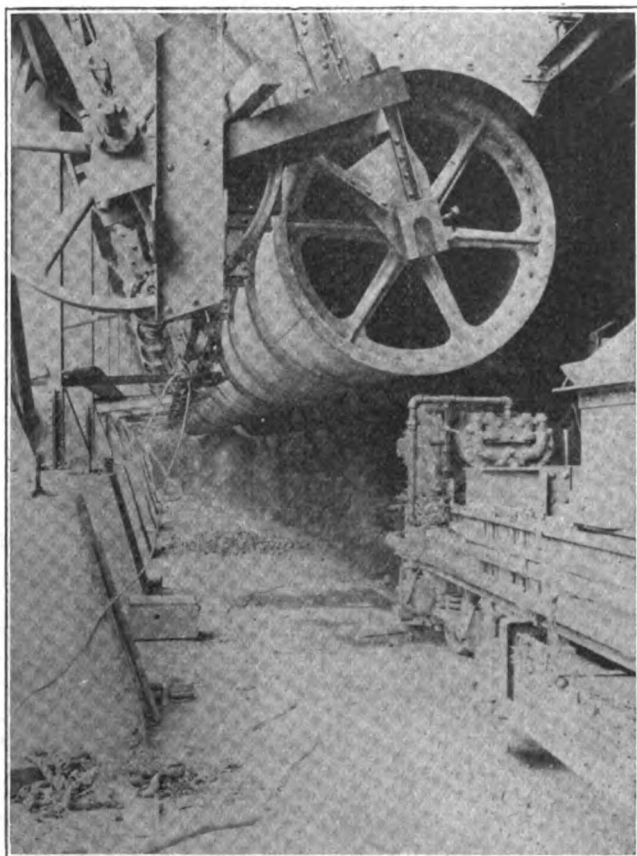


Hot blast stoves, two-pass type. Each stove is provided with one gas burner, one cold blast connection, one hot blast valve, with a special device for changing valves and seats.

blowing engine house. Through it are run water supply pipes, circulating water lines to condensers, steam lines to circulating pumps, and exhaust steam lines returning to feed water heater. This tunnel also serves as a subway for use of employees.

Boiler Plant.

The old boiler plant was torn down and a new one erected. It consists of seven 700 hp Stirling boilers, which furnish steam at 200 lbs. pressure and 100 degrees superheat. The loop system of steam and feed water piping is used, so that no ordinary acci-



Roller gates which discharge stock mechanically into electrically driven larry cars.

dent can put out of commission more than two boilers. All the steam generating plants of the works are inter-connected, resulting in a great saving of fuel. These boilers are fired entirely by blast furnace gas through burners of special design which give practically perfect combustion. They are thoroughly equipped with recording instruments so that a record of the efficiency of each boiler is available at all times. This is a subject to which the company has given special attention for several years. Boilers are set singly with individual stacks 200 feet high. Water for the boilers is pumped from the condenser hot wells into a Scaife We-Fu-Go plant, where it is treated chemically and filtered. It is then pumped to a 15,000 hp feed water heater where the temperature is increased to 210 degrees. It is then supplied to the

boilers by either of two centrifugal pumps in which the pressure is automatically controlled.

Ore Handling Equipment.

A large receiving yard has been built to take the train loads of ore from the various railroads. It is then switched by the company's own locomotives to a Wellman-Seaver-Morgan car dumper, which turns the car upside down and dumps the ore directly into the ore yard. The car dumper has a capacity of 30 cars per hour. The ore yard is 200 feet wide and has a capacity of over 500,000 tons, which may, in the future, be doubled. The sides of the yard consist of massive concrete walls 30 feet high, on top of which travels a Hoover & Mason ore bridge, equipped with 15-ton grab bucket which deposits ore into a 100-ton bin built on one end of the bridge. The bridge trucks are anchored by ropes run from drums and fastened to the ends of the concrete wall. This keeps it from running away during high wind storms. From the 100-ton bin at the end of the bridge the ore is discharged through electrically operated gates into either of two 60-ton transfer cars, motor driven, and equipped with airbrakes and side discharge operated by air. These transfer cars travel on standard gauge track and fill the bins of all three furnaces. The bin system of the new furnace consists of 10 double compartment structural steel Hoover & Mason bins, each compartment fitted at the bottom with two roller gates for discharging the stock mechanically into either of two larry cars, running on a standard gauge track underneath the bins. These larry cars are mounted on scales with automatic dials. They are electrically driven and equipped with airbrakes and airdump for discharging the ore into either of the skip cars, when it is taken to the top of the furnace, as previously outlined. The skip pit is built of heavy waterproof concrete with reinforced concrete platforms around the cars, and concrete stairways; thus affording easy means of cleaning the pit.

Eighty-four and 132-inch Plate Mills.

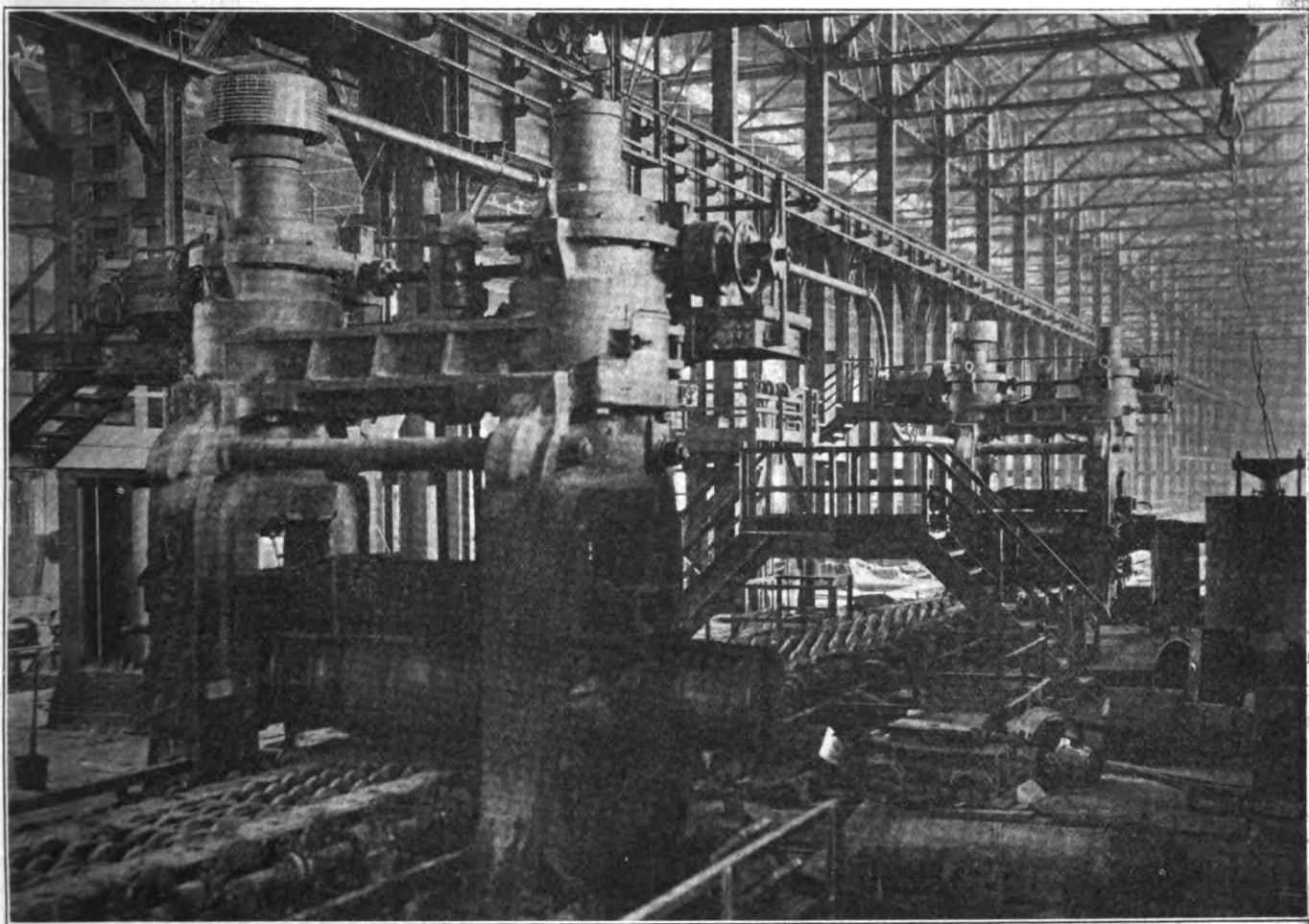
The Brier Hill Steel Company has recently completed the construction of two plate mills. Both mills are under one roof. The mill building is reputed to be the largest in the world. Particular attention has been paid in the design to give the capacity of heating, finishing and shipping, equal to the full capacity of the rolls. It is in this feature that the arrangement is superior to all others. Both mills, one 84-inch and the other 132-inch, are driven by electric motors with power furnished by the Republic Railway and Light Company, and should be particularly free from smoke and dirt. The boiler plant has been dispensed with, as the only steam needed will be used for heating the substation and motor rooms, and possibly for blowing scale from the steel. This steam is furnished through an underground conduit from the

New Pate Mills with Modern Lay-out

Particular Attention in Design to Give Sufficient Capacity of Heating, Finishing and Shipping, Equal to the Full Capacity of the Rolls at Brier Hill Steel Company—Large Mill Building.

The 84-inch mill consists of two stands of rolls, set in tandem 77½ feet apart. One of these stands is a two-high reversing rougher, with 32x84" rolls. The other, or finishing stand is three-high with 32x84" top and bottom rolls and a 22x84" middle roll. Both stands have steel housings, electric screw downs, enclosed pinion housings and helical cut pinions. Finishing

ing on two standard gauge tracks, giving dock room for eight cars in the building. This end of the building for a distance of 120 feet, has been left vacant. It is, at present, utilized for the storage of slabs and furnishes a satisfactory location for extension should it become necessary to install additional heating furnaces or soaking pits, in the event that ingots will



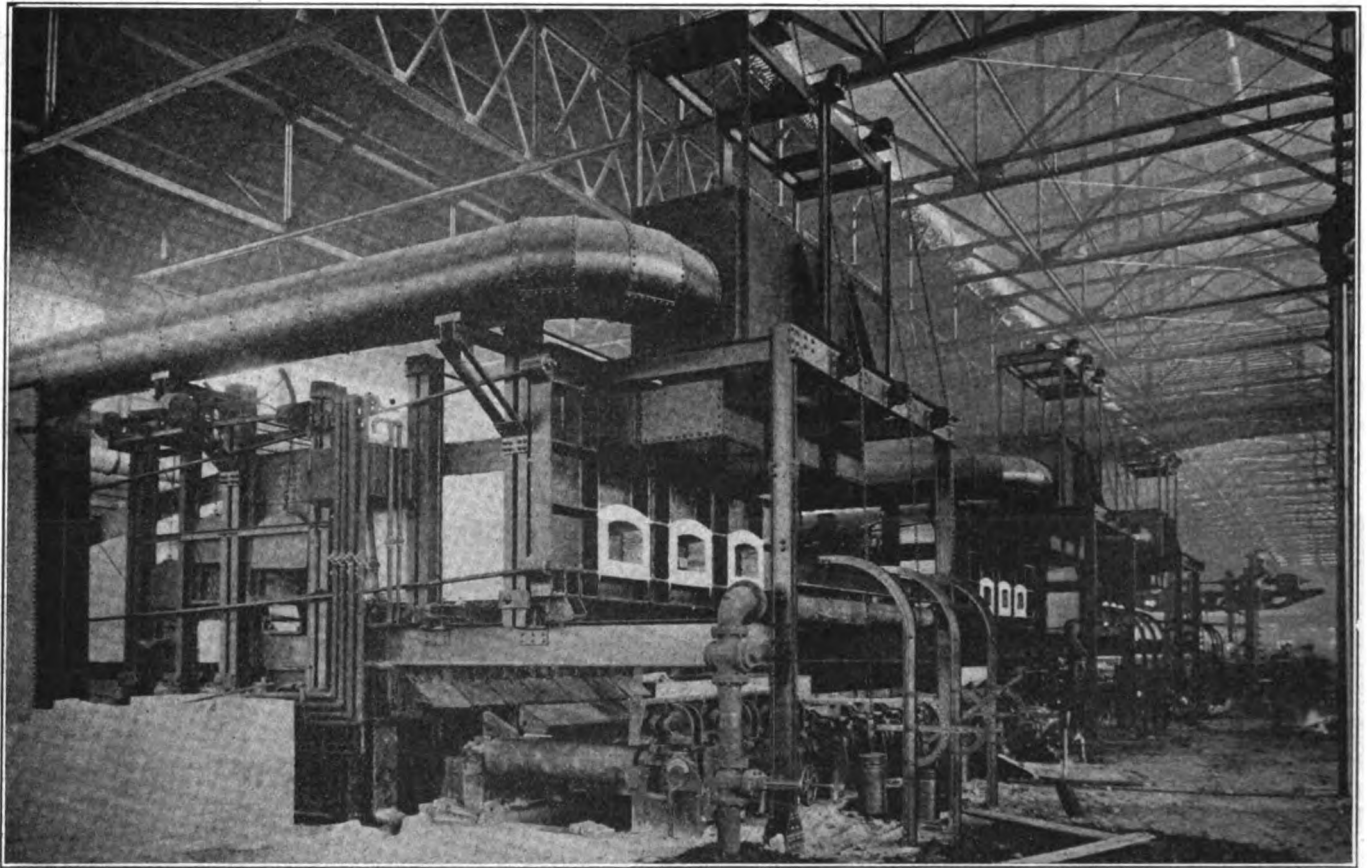
Entering side 84-inch two-high roughing stand with three-high finishing stand in the distance. Gear guards on tables and spindles removed.

stand has hydraulic balance and the reduction gear pinion housings are of the Kennedy type. The front and rear tables of each stand have disc rollers, running in Hyatt bearings. On each side of the three-high mill are tilting tables 30 feet long with electrically driven lifting motion and balanced by the hydro-pneumatic system.

Eighty-four-inch Mill Operation.

The slabs are brought into north end of mill build-

ing have to be rolled. A 15-ton overhead crane, equipped with magnets, takes slabs from the storage piles and deposits them on the pusher tables of three coke oven gas fired recuperative continuous heating furnaces 9 feet wide inside by 44 feet 6½ inches long outside. The furnaces are of the automatic gravity discharge type and were built, together with the 5x125 foot stacks, by Alexander Laughlin & Co. Pushers are of the double rack type, electrically operated. They are spaced 40 feet between centers, the nearest being 52

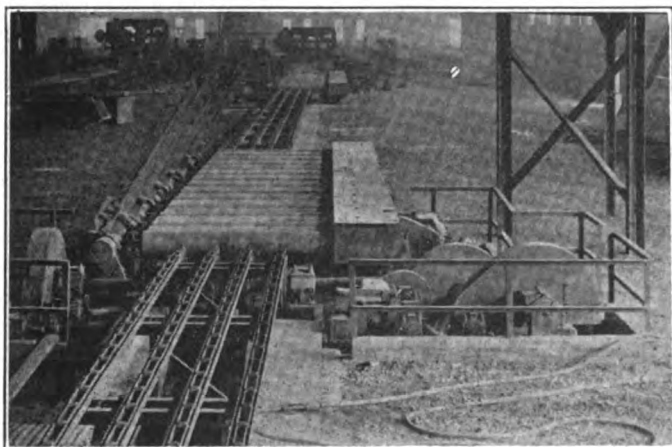


Discharge end of heating furnaces.

feet distance from the two-high rougher. They have their combustion chambers immediately over the roller tables on which the slabs are discharged, and conveyed to the mill. After being broken down to $\frac{1}{2}$ -inch or $\frac{5}{8}$ -inch thickness by the roughing stand, the plates are finished in the three-high.

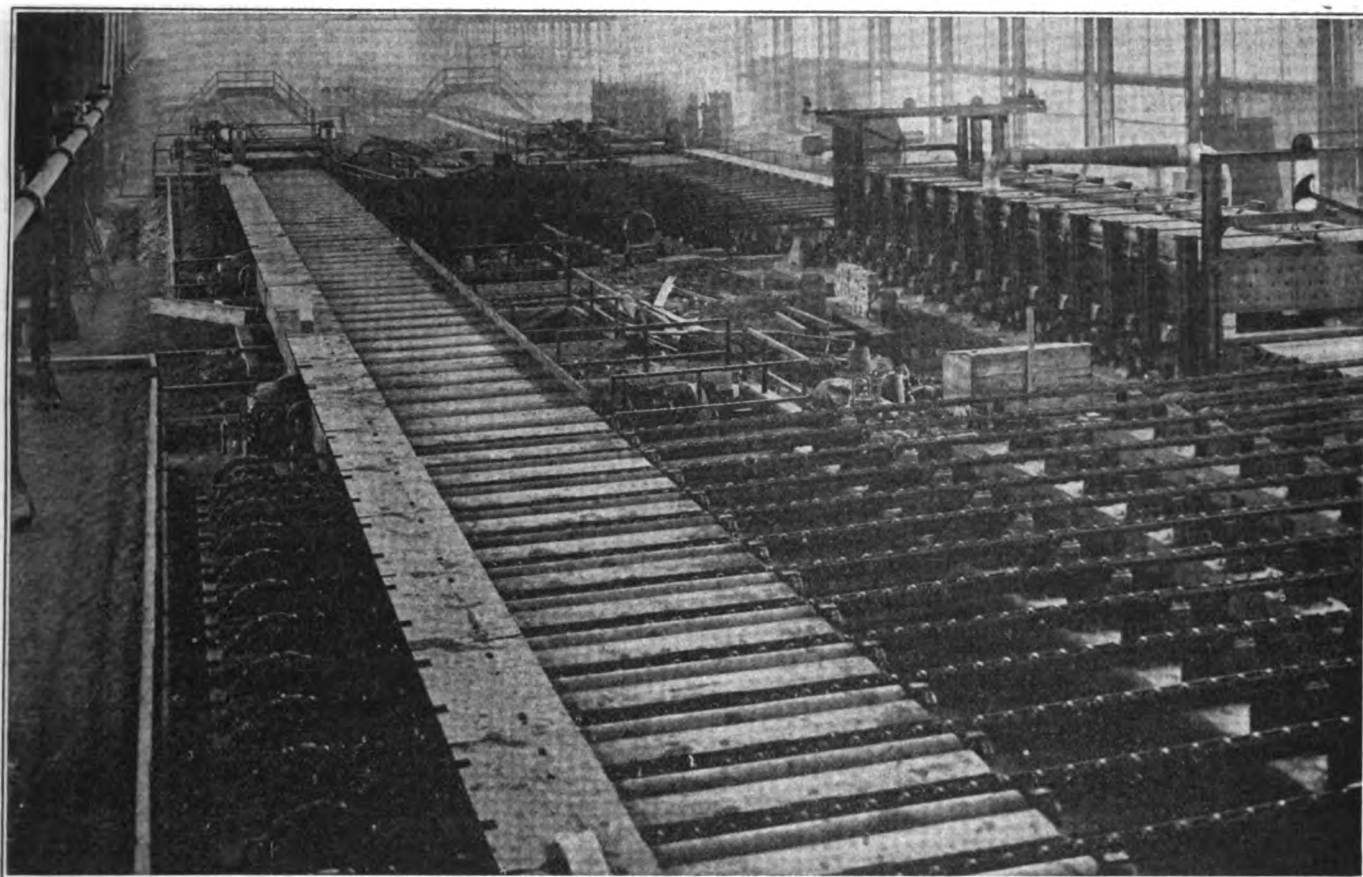
Beyond the rear table of the three-high stand, are two systems of tables parallel to each other, 40 feet apart, and practically duplicate, except that one system includes a Costello continuous annealing furnace 50 feet long. These two systems are connected by two 40 foot roller chain transfers, one at each end of the

annealing furnace. The one system of tables, directly in line with the roll stands, is used for light plates. Such of the latter as require annealing, are transferred from the heavy side in front of the annealing furnace; the others are transferred behind the annealing furnace. Each system is equipped with its own inspection table, shears, scales, and shipping dock, thus increasing the actual time the roll stands are being used, and practically doubling the output of the mill. A description of the movement of the heavy plate will suffice for both systems and is herewith appended in detail:



View of inspection table showing arms for raising plates.

After leaving the rear table of the three-high stand, the plate continues in a straight line over roller tables into a plate leveller 206 feet from the mill. From the leveller, is it discharged by a table 40 feet long to a roller chain conveyer 140 feet in length, which delivers it to the inspection table, which is a roller table approximately 40 feet long. An automatic device is provided here to turn the plates up on edge, so that the under side may be carefully inspected. The plate is also marked at this table. After inspection and marking, the plate is carried by another roller chain conveyor 102 feet long and delivered to a 55-foot roller table by which it is carried into the rotary side cut shears. These shears trim both sides of the plate at the same time. They are adjustable for any width of plate, one side being stationary, while the other is



View taken from top of 84-inch finishing stand looking towards shearing department. Annealing furnace at right.

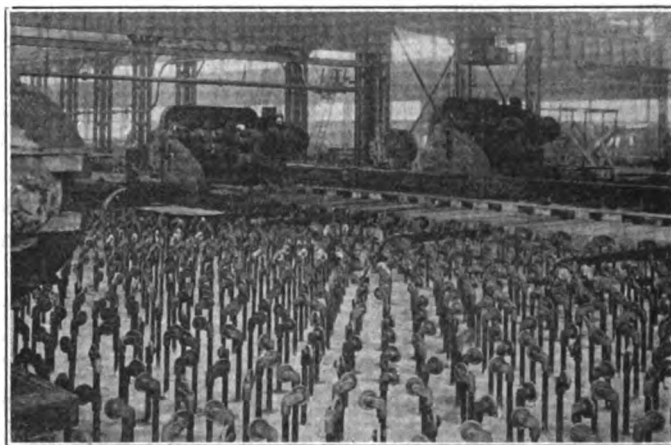
moved by a screw driven by a motor through gearing. A gauge is provided at the shears, so that they may be spaced the proper distance apart, without requiring the operator to get near the plate. After passing through the rotary shears, the plate is pushed up against a stationary straight edge by an electric screw clamp, and then travels over a roller table to a 108x1½-inch end cut shear, which is electrically driven through gearing, and is equipped with a magnetic hold down. This machine is 71 feet from the rotary shears. After its ends are sheared, the plate moves out over a 60-foot roller table to a 50-foot scale of 15-ton capacity from which it is carried by an overhead crane to the shipping dock. The plate can be transferred just before it reaches the scale just mentioned, by a lifting roller chain pull-off which takes it from the 60-foot roller table over a castor-bed, to a 156x1-inch side cut shear, 45 feet from the center line of run-out table. This is used in case it is not desired to trim the sides of plate by the rotary shears, or in case of accident to them. Finished plates thus transferred are weighed on another 50-foot, 15-ton scale immediately adjacent to the castor bed.

One Hundred and Thirty-two-inch Mill.

This mill consists of one three-high stand 38x132-inches top and bottom rolls, and 24x132-inches middle roll. It has electric screw down, hydraulic balance, steel housings, and Kennedy type enclosed reduction

gear housings. Both in front and rear of mill is a 35-foot lifting table, equipped with electrical lifting device and hydro-pneumatic balance. The rollers of these tables run in Hyatt roller bearings.

The north end of building is the same as previously described for the 84-inch mill. The slabs are transferred by overhead crane from storage pile to pusher tables of three coke oven gas fired Alexander Laughlin heating furnaces, the same as installed for the 84-inch mill, except that they are 11 feet wide inside. The roll stand is 110 feet from the nearest heating furnace. After leaving the rolls, the finished plate is carried by a roller table to the plate straightener which is

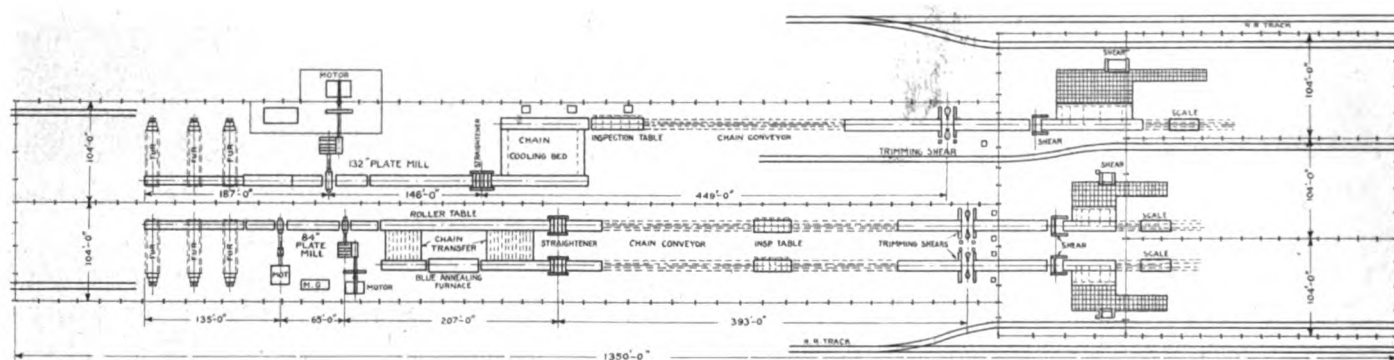


Back view of cross-cut shears showing runout tables.

146 feet 6 inches from the mill, and thence to a roller table 105 feet long. From this table the plate is transferred over a 90-foot transfer of the Aiken type for a distance of 60 feet and deposited on another roller table which carries it to an inspection table 52 feet in length. This table is equipped with an automatic device for turning the plate on edge to allow continuous inspection of the under side. The plate is then carried by a 200-foot roller chain conveyor to another roller table 80 feet long, at the end of which it enters rotary side cut shears, which are duplicate of those on the heavy side of the 84-inch mill. The plate is then pushed over by an electric screw clamp against a stationary straight edge, thus insuring square cuts at the end shear, 90 feet distant. This shear was built by R. D. Wood & Co., is hydraulically operated, and equipped with magnetic hold-down. From this point, there are two routes for the plate. If of medium thickness, it passes over a 90-foot roller table to a roller chain conveyor 90 feet long, mounted in twin tandem scales of 20-ton capacity, thence taken by an

supplying the power to reversing motor, consists of a 1,500 hp. wound rotor induction motor driving a 2,250 kw generator of the compensated interpole type. This generator has a separate exciter. Peak loads are absorbed by a 60,000-pound cast steel flywheel, 15 feet, 5 inches diameter. The reversing motor is controlled by magnetic switches in the field circuit of the generator. The 84-inch three-high mill is driven by a 2,500 hp wound rotor induction motor running at 240 rpm synchronous through a flexible coupling and single reduction gearing. The peaks are absorbed by a 35-ton cast steel flywheel 16 feet in diameter. The exciter set consists of two dc generators driven by an ac motor of the squirrel cage type.

The 132-inch mill is driven by a 5,000 hp wound rotor induction motor running at a speed of 200 rpm synchronous, through flexible coupling and single reduction gearing. A 60-ton cast steel flywheel 19 feet in diameter is mounted between the motor and gear housing to take care of peak loads. The reversing motor with its flywheel generator set and the motor



Plan of plate mill.

electric crane to the shipping dock or warehouse. If, however, the plate is of heavy section, it is transferred from the above mentioned roller table behind the shears over the castor bed to a 215x2¼-inch R. D. Wood Company hydraulically operated slitting shear 45 feet distant, thence over the castor bed to a 50-foot, 15-ton scale, from which it is carried by the overhead crane to shipping dock or warehouse.

Electric Drive.

Power furnished by the Republic Railway and Light is brought in at 60 cycle, three-phase, 66,000 volts. Voltage is reduced in 3,500 kva outdoor transformers to 2,200 volts. From the transformers it is transmitted to the main substation which is on the 84-inch side, and to the motor room on the 132-inch, through spacious under ground tunnels, carefully waterproofed and insulated. The 84-inch two-high rougher is driven by a dc reversing motor of 1,000,000 pounds-feet torque. This maximum torque is available throughout the speed range, from zero to 40 rpm. The flywheel motor generator set

for the 84-inch three-high, together with exciter set and slip regulators, are installed in the main substation on the 84-inch mill side of the building. Part of this substation extends into the mill building proper; the remainder being a lean-to on the outside. In this room also are installed two 750 kw motor generators for supplying power to the table, motors, etc. The switchboard equipment is in the basement of the leanto. The substation throughout has been finished attractively with special attention paid to illumination and cleanliness. The motor for driving the 132-inch mill is installed in a leanto on the outside of the mill aisle. This leanto is 35x180 feet long. In it are located also the hydraulic pumps, accumulator, air compressors and air receiver.

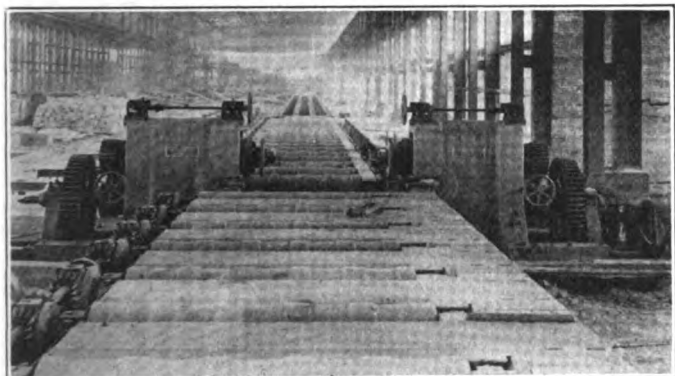
Auxiliary Equipment.

There are 10 100-foot span electric overhead cranes, all furnished by the Morgan Engineering Company. Two are of 25-ton capacity, the others 15 ton. In each main mill aisle there is a 15-ton crane for handling slabs at the heating furnaces and a 25-ton crane

for miscellaneous work. The shear building has one crane running its entire length. The warehouse contains five cranes, one in the center aisle and two in each outside aisle. All cranes have five-ton auxiliary hoists.

Hydraulic Pumps.

Hydraulic pumps furnish water at 550 pounds pressure for the hydraulic shears, lifting table, balance, etc. There are three of these units, each of 600 gallons per minute capacity. They were built by the Wilson-Snyder Manufacturing Company, and are of the motor driven horizontal duplex outside center and packed type. They have quarter box main bearings, rolling mill type frames, and are driven through Faulk herringbone gears by 300 hp synchronous motors controlled by a push button start and stop station. An automatic unloading device connected to the accumulator regulates the amount of water pumped to conform with the amount required. The pressure is equalized by a 24-inch by 15-foot accumulator. A separate



Large rotary shear on 132-inch mill. View looking towards the mill.

accumulator 12-inch diameter by 12-foot, is connected to the pullback of the shears. This avoids excessive vibration and strain on the shears.

Air Compressor.

Compressed air is delivered at 100 pounds pressure by an Ingersoll-Rand Imperial XB 2 machine of 900 cubic feet per minute capacity, driven by a 150 hp synchronous motor, through Ingersoll-Rand's well known short belt drive.

Scales.

All of the weighing equipment for both mills consists of scales manufactured by the Strait Scale Company, equipped with automatic dials, furnished by the American Kron Scale Company. These dials are 36 inches in diameter and are graduated to read 10,000 pounds in increments of 10 pounds. At present, standard gauge cars must be weighed at the steel works, but when certain railroad re-location is finished, all inbound or outbound cars for the plate mills will be weighed on Strait scales 50 feet long and of 150-ton

capacity A. R. A. rating, installed on the new site.

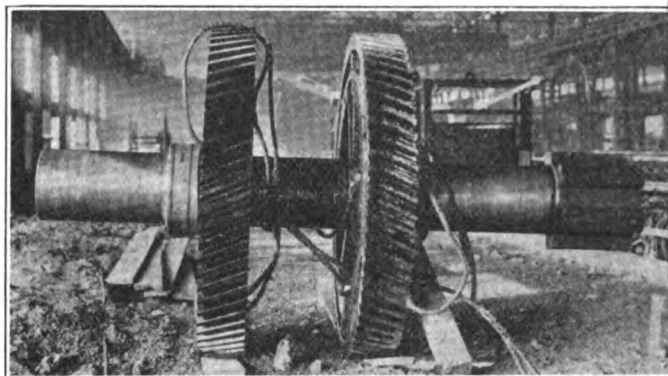
The mill tables and similar equipment driven by General Electric drive are supplied by two S. F. Bowser Company type 6-F oil circulating and purifying systems, one for each mill. The receiving tanks for these systems are located in the basement of the substation; the filter tanks and the electric pump, on the main floor.

Mill Table Motors.

The mill tables and similar equipment are driven by General Electric mill type dc motors, equipped with automatic magnetic control. These controls are grouped in three small leanto houses for the 84-inch mill and one leanto for the 132-inch mill.

Oiling Systems.

Oil for the main bearings of the mill equipment including the electric drive, is supplied by two S. F. Bowser Company type 6-F oil circulating and purifying systems, one for each mill. The receiving tanks



Construction of bottom pinion on 84-inch finishing mill.

for these systems are located in the basement of the substation; the filler tanks and the electric pumps, on the main floor.

Circles and intricate sketch plates are trimmed by a circle shear built by R. S. Newbold & Co., with a maximum capacity of 126 inch diameter by $1\frac{1}{2}$ thickness. These shears are located in the warehouse near the south and together with a 156x9/16-inch No. 4 U. E. & F. resquaring shear. The knives for the circle shears, just mentioned as well as those for the rotary shears, are finished on a universal grinding machine furnished by the Landis Tool Company. This machine has 24-inch swing with 32 inches between centers, and is motor driven. The knives for all straight cut shears are finished on a Bridgeport Safety Emery Wheel Company's grinder with a maximum capacity of $16\frac{1}{2} \times 2\frac{3}{8} \times 215$ -inch knives. These two machines are located in the shear building. Belts are finished on two 50-inch roll lathes, one of which was built by the Youngstown Foundry & Machine Company and the other by Hyde Park Foundry & Machine Co.

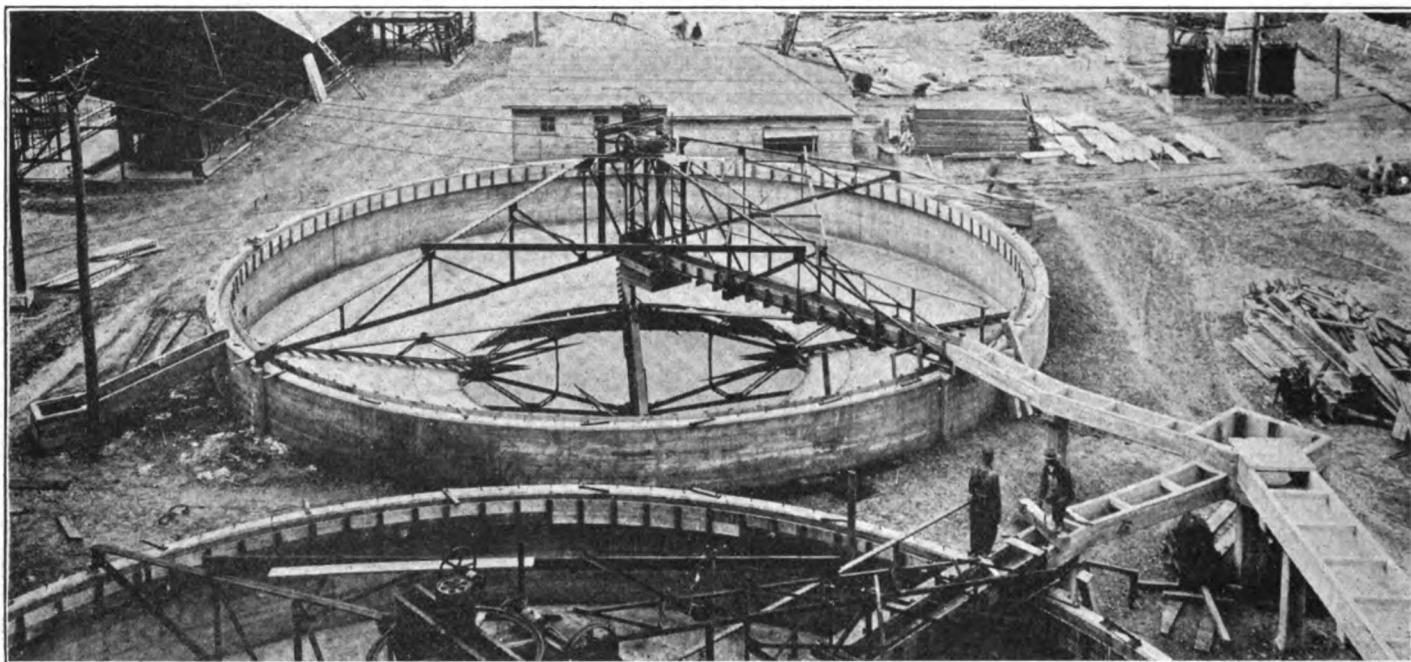
Dust Recovery from Gas Scrubber Water

Dorr Thickener Installed in Blast Furnace Plant to Continuously and Automatically Provide for the Settlement of Dust from Gas Scrubbers—First Installation at Chicago.

Particular interest has been attracted during the year to the application of the Dorr thickener, for the recovery of dust carried in gas scrubber waste water discharge. This device has been installed at the furnace plant of the Illinois Steel Company, and it is reported to be under consideration for several blast furnace plants.

The function of the Dorr thickener in this work is to continuously and automatically provide for the settlement of the solids carried in suspension in the water from the scrubbing towers and to remove the resulting sludge from the basins. Heretofore inter-

consists of a shallow concrete basin with a slightly sloping bottom equipped with a thickener mechanism supported in the tank by a steel superstructure. The mechanism has four slowly revolving arms equipped with inclined plows which move the settled material to the center where it is discharged as a thick sludge through a bottom discharge opening. The discharge is controlled by a Dorco diaphragm pump, which elevates the sludge to the level of the liquid in the basin, or a few feet above, which makes for easy disposal or delivery to the following steps in the treatment process. The water, sufficiently clarified for



View of Dorr Thickener—This particular installation is used in connection with a coal washery.

mittent settling basins have been used for this purpose, one basin being in use while another was being cleaned of the accumulated sludge. As large quantities of sludge are collected the cleaning of the basins is an expensive operation.

Dorr thickeners have been in use for a number of years in the wet metallurgy of gold, silver, copper, lead, zinc, and other ores, and also in a number of chemical and industrial operations as well as in the treatment of sewage water and trade wastes. They have recently been very successfully applied to the recovery of fine coal and usable water from the waste waters from coal washeries.

The accompanying illustration shows a Dorr thickener installation at a coal washery. As will be noted it

reuse, overflows continuously and is collected in a peripheral channel. While thickener installations out of doors are usually made in concrete basins or earth bottom tanks, with wood stave walls, simple excavations in the ground may be used. Mechanisms are built for tanks ranging in size from 6 feet to 200 feet in diameter.

The capacity of a thickener varies with the character of material and the individual requirements and no general figures can be given but it is of interest that one thickener 200 feet in diameter is discharging from 3,000 to 4,000 tons of solids and 4,000,000 to 5,000,000 gallons of water daily and that its operation requires less than 3 hp and only part of one man's time.

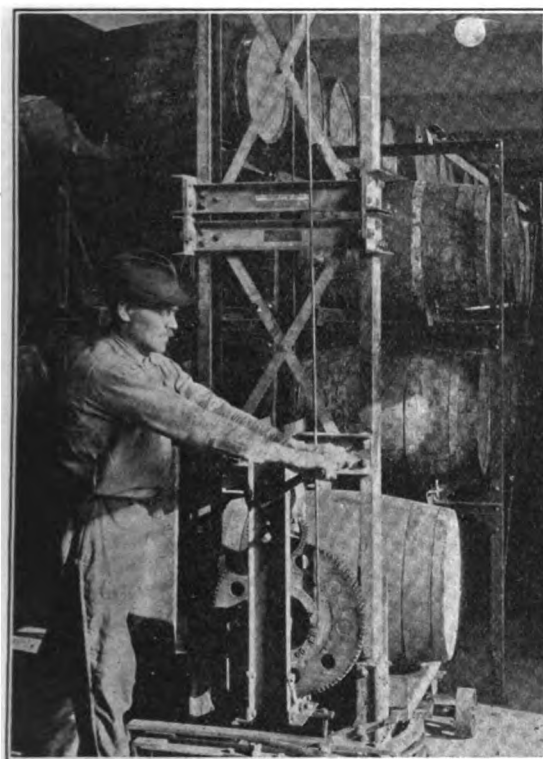
Modern Steel Mill Oil House Installation

Central Distributing Point for Oil at Youngstown Sheet and Tube Company Plant—Building of Concrete Monolithic Construction With Modern Equipment—Able to Handle Large Quantities of Oil.

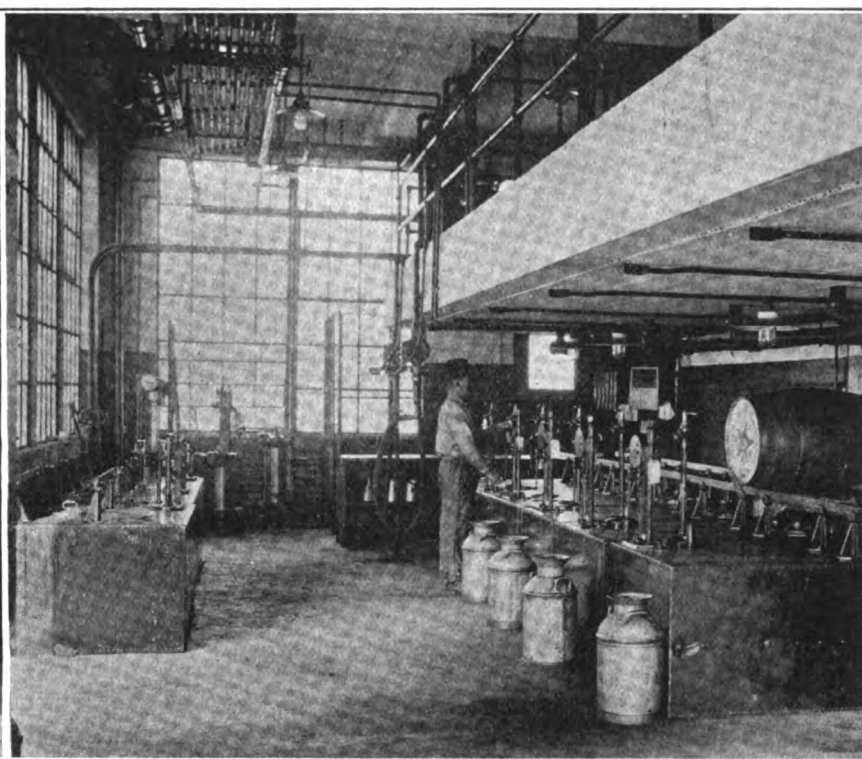
During the past year the Youngstown Sheet & Tube Co. has built an interesting oil house to take care of the needs of their plant. The building is of concrete monolithic construction with brick curtain walls and steel sash, 62 ft. 8 in. x 133 ft. 6 in. outside dimensions. The level of the first floor is 4 ft. above grade, the height of the first story 15 ft. 6 in., and the second story about 11 ft. high, varying on account of the slope of the roof, which is highest in the center of the building. The steel sash in the storage rooms are 10 ft. 4 in. above the floor and 3 ft. 6 in. above the floor in the service room, office and laundry.

tanks. All the tanks are of the vertical type, the 15,000-gallon tanks being 10 ft. in diameter and 24 ft. high, the 1,500-gallon tanks 5 ft. in diameter and 10 ft. high, the 2,500-gallon tanks 6 ft. in diameter and 10 ft. high.

The storage room is equipped with structural steel racks having a capacity for 1,350 barrels. The handling of the barrels to the upper tiers of the racks being accomplished by the use of a portable hand-operated elevator. Shipments from this room are handled either to or from cars or wagons. The elevator is of the freight type and is used to handle material for storage on the second floor. The elevator is equipped with the Peele



Portable hand operated elevator.



Service Room. Barrels can be emptied into storage tank above.

The building is divided in three sections. At the east end is the tank room, the floor of which is about at the yard elevation, the height extending to the height of the first and second stories of the other sections of the building. In the center are the storage rooms consisting of oil barrel storage space on the first floor, with storage for lighter stock such as waste, etc., on the second floor. The west end of the building is arranged for a service room, which is equipped with a gallery for the pumping equipment on the first floor and an office and a laundry on the second floor.

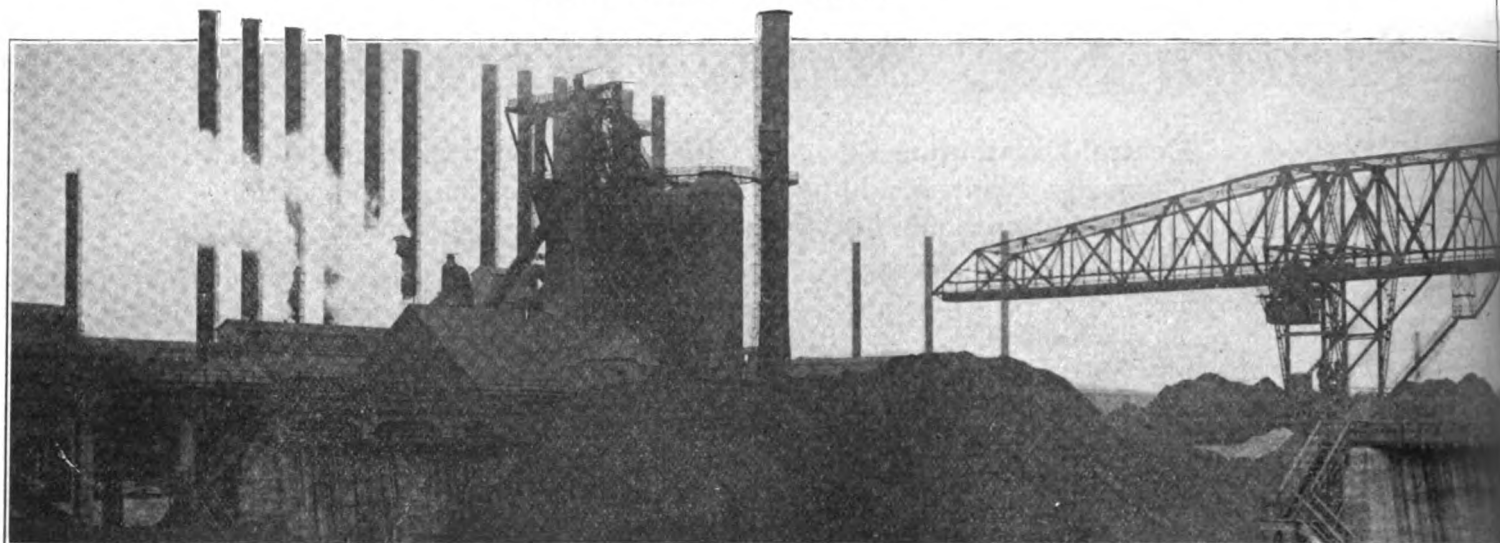
The tank room is designed to contain nine 15,000-gallon tanks, three 1,500-gallon tanks and one 2,500-gallon

type of door, dividing horizontally in the center, the top of the lower section forming a continuous trucking sill when the door is open.

The service room is arranged with a steel counter with a wire grille forming a waiting room. Shipments can be handled from this room on to a shipping platform across the full width of the building.

The oil is handled from tank cars to the storage tanks or from the storage tanks for distribution, by the same pump, by means of by-passes and a system of valves. Connections are made from tank cars to pipes extending outside of the building through which it

(Continued on page 59.)



NUMBER 1 furnace at the Mark plant of the Steel & Tube Co., of America, was blown in August 24, 1918. This furnace is the first of a line of furnace stacks planned for the new steel plant, and the general arrangement of furnace and furnace equipment is such that construction and operation of additional stacks will tie in to the existing equipment without handicap to operation of present furnace, power plant and water station.

The site of furnace, stoves and ore yard was covered by Lake Michigan in 1916. In July, 1916, pumping for fill was started. The total fill is 700 feet wide

The furnace plant of this company as shown in the above illustration was entirely built on filled ground. In 1916 the entire site of the plant was covered by Lake Michigan. The fill is 700 feet wide and extends 3,000 feet into the lake. The depth of the water front shown at the extreme right of the illustration on the opposite page, is 25 feet deep. Three more furnaces are to be built to operate in connection with this plant.

and extends 3,000 feet into the lake, the general yard level being 16 feet above lake surface. The depth of water at the outer end of the fill is 25 feet. Blast furnace, stove, trestle, ore yard, ore dock, building and machinery rest on pile foundations, 70 foot wooden piles being used for heavy loading. A total of 1203 piles was driven for the furnace foundations.

Ore is unloaded at a 550 foot concrete dock by two Hoover and Mason unloaders, equipped with 7½-ton buckets. The unloaders discharge from boats to two lines of cars or to a trough, at a rate of 400 tons per hour, each. From the trough, a Hoover and Mason bridge with 15-ton bucket, handles ore to ore yard, to

Blast Furnace Plant

**Number One Furnace First of Series of
The Steel & Tube Co. of America.
Thirty Inch Universal Plate Mill to Roll**

Hoover and Mason bin transfer car, or to bins direct. The bridge is 562 feet over all and spans an ore yard having capacity of 800,000 tons. The yard is divided into three sections to facilitate definite stocking of varying ore grades. Hoover and Mason bins were installed, consisting of eight double ore and limestone bins discharging into a Hoover and Mason scale car, and of one double coke bin discharging direct to skip car.

Adjoining the furnace plant on the other side of the E. J. & E., B. & O., and N. Y. C. lines right-of-way, is the coke plant of 120 Semet-Solvay ovens, from which coke will be brought direct to bins by belt conveyor.

The skip pit tank bottom is 35 feet below yard level. Two skip cars of 110 cubic feet capacity serve the furnace, skip hoist being the Lidgerwood single motor type, equipped with Westinghouse 200 hp motor and Cutler-Hammer control. The skip house, which is located below the skip and above the iron ladle track, also contains the bell cylinders. These are operated by air either from the cold blast main or from the air compressor line. Skip car and bell control is located for operation from scale car.

The skip incline is of the cantilever type, supported independently of the furnace shell. It is 176 feet long and has an angle of 60 degrees from horizontal.

For the first furnace, a unit cast house is provided. For future furnaces common cast houses are planned. The present cast house is 90x104 feet with steel plate roof. Iron runners are provided for four ladles on the east side. The iron ladle equipment consists of 60-ton



Blows in First Stack

Four to Be Built at the Mark Plant of Dean Valve Control for Air Regulation. Plates or Skelp 8 to 42 Inches in Width.

Pollock ladles, three being spotted for cast. The iron is delivered by ladle either to a Pittsburgh Coal Washer Company pig casting machine or to the four 90-ton open hearth furnaces.

On the west side are the four cinder spouts, serving 300 cubic foot capacity cinder ladles. Ladles only are used at present for cinder disposal. Provision is made for a granulating pit and also for granulation into a flume for further fill on the company's property. The cast house is served by a monorail.

The top of stove foundation is placed at the same elevation as the cast house pavement about the base of the furnace, thus facilitating the work of the furnace force, and more particularly—providing a general working level and thoroughfare for foremen and repair crews for the group of furnaces. The stoves are not placed in line but are arranged in a triangle. Two stoves are placed on one side and the third stove with the stack on the opposite side of a line running through the centers of the furnace. The arrangement of the stoves for the second furnace will be similarly symmetrical so that the six stoves (of two furnaces) with their common stack are en bloc. They cover the minimum space, shorten the distance between furnaces, and make possible economy in yard room for a given group of furnaces.

The stoves, three in number, are each 22 feet in diameter by 100 feet high. They are of the two pass, side combustion chamber type, checker, arch and draft chamber design, according to the Brassert-Jones patents. Each stove has 95,000 square feet of heating surface and has 425,000 9-inch equivalent brick. The ratio of heating surface to cubic contents of all brick-

work in stoves is 3.8, an exceptionally high ratio. There are 11.2 9-inch equivalent brick per cubic feet of stove capacity, which represents a large amount of brick, together with unusually high heating surface exposure. This factor, together with the forcing of equalization of flow of descending gas and ascending air through the checkers by virtue of the patented construction, gives high heats which are maintained for a two-hour blast period. Good gas economy is also attained, stack temperatures on the stoves at the end of four hour gas periods being under 450 degrees. The stoves are equipped with Universal stove burners, Mathesius hot blast gate valves, and are insulated

There are several unique features in this new blast furnace plant. This is believed to be the first installation of combined blast furnace gas and chain grate stokers firing on heavy mill loads. Clean gas is of particular importance in this case, and this question has been given careful attention. The gas cleaning is so designed as to keep both stoves and washer clean and in operation throughout an entire blast campaign.

with Sil-O-Cel brick and powder. Stove top platforms and also the furnace top are reached by a 1,500-pound capacity freight and passenger elevator. It is placed at the stove stack.

The blast furnace has the following dimensions:

Hearth diameter	18' 6"
Bosh diameter	22' 6"
Stock line	17' 0"
Height	92'
Cubic capacity	25,500 ft.

There are 10 tuyeres, and 10 columns supporting a steel plate mantle and resting on a continuous cast iron sub-base. The columns are spread out, the radius of the base circle being greater than the radius

The image contains two detailed architectural drawings of a blast furnace, labeled 'SECTION-AA' and 'SECTION-BB'.

SECTION-AA is a longitudinal section showing the furnace's internal structure. It includes the 'Top of Blast Furnace' at an elevation of 135'-0", the 'Top of Furnace' at 126'-8", and the 'Top of Blast Furnace' at 135'-0". The section shows the 'Furnace' proper, the 'Cold Blast Main', and the 'Hot Blast Main'. It also depicts the 'Top of Blast Furnace' at 135'-0" and the 'Top of Blast Furnace' at 135'-0". The section is 439'-7 1/2" long.

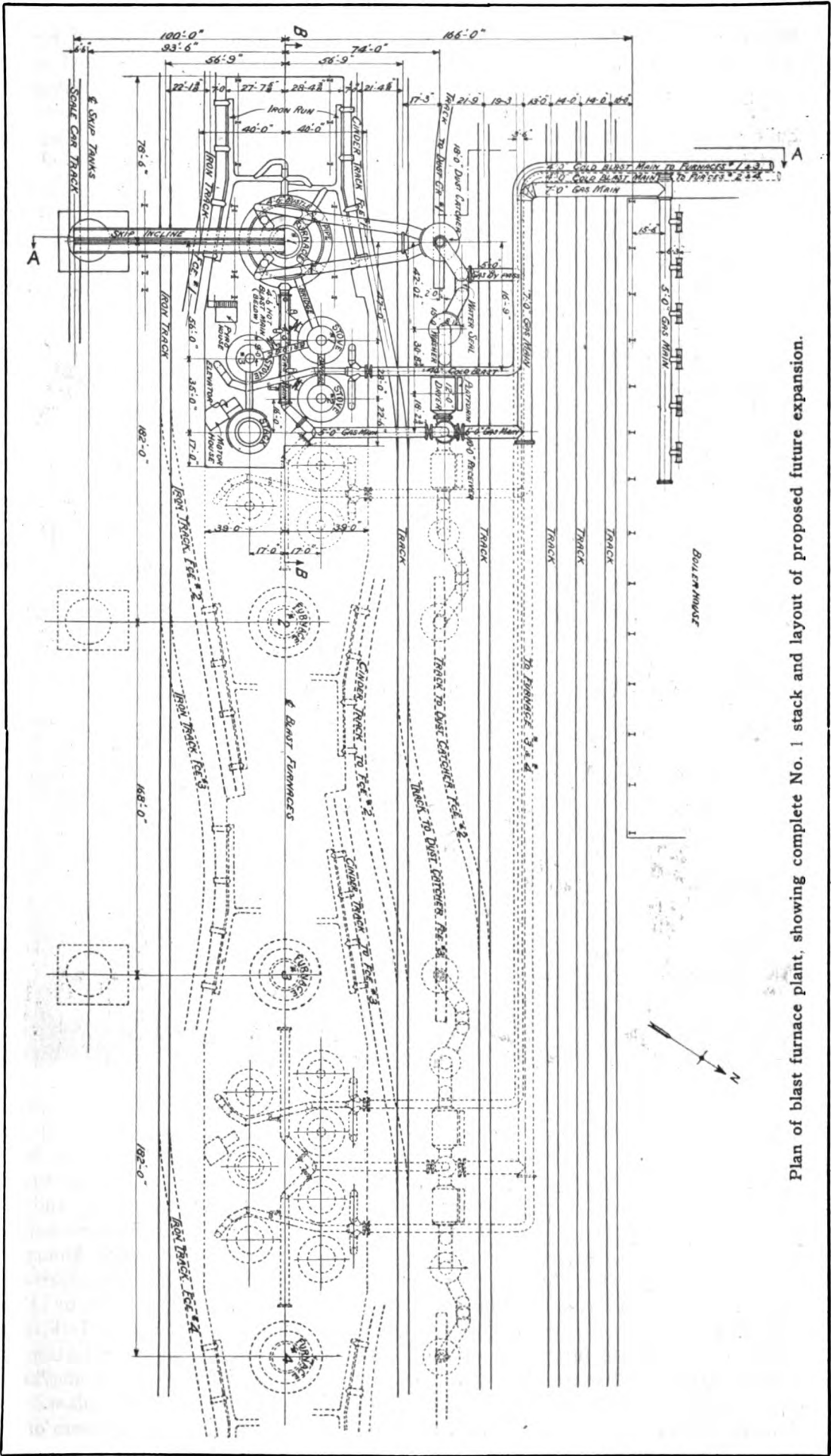
SECTION-BB is a cross-section of the furnace. It shows the 'Top of Blast Furnace' at 135'-0" and the 'Top of Blast Furnace' at 135'-0". The section is 176'-0" wide. It includes the 'Furnace' proper, the 'Cold Blast Main', and the 'Hot Blast Main'. It also depicts the 'Top of Blast Furnace' at 135'-0" and the 'Top of Blast Furnace' at 135'-0". The section is 176'-0" wide.

The furnace top is of the Brassert design, dimensioned to decrease flue dust production and to give certain contour of burden materials at the stock line. The skip lip, angle and speed and stopping point of skip dump, the receiving hopper, hopper throat and bell are determined for correct distribution. The top is designed for centering and adjustment of the above parts to control uniformity of distribution and to maintain regular performance of the furnace, thereby assuring uniform wear of lining.

Original from
UNIVERSITY OF CHICAGO

are equipped with Baer safety explosion valves. There are four down-takes, each combining into one downcomer. The two downcomers enter the dust catcher radially. The dust catcher is equipped with bleeder at the top where the gas leaves. The gas passes through a "U" type water seal to a 15 foot Brassert washer, then enters a 12 foot horizontal dryer, from whence it passes to a vertical gas receiver and water seal designed for connection to No. 2 furnace. From the receiver, one main leads to the stoves and a larger main to the boiler plant. (An auxiliary main is provided so that the boiler house may be operated with unwashed gas and to enable by-passing the washer entirely).

The gas washer is the standard two-stage Brassert type, comprising a first rough cleaning stage to eliminate the heavier portion of the dust and to cool the gas, and followed by a second stage to precipitate fine fume and dusts. All of the water is added in the second stage on top, through special spray nozzles, in such a manner that the gas and a rain of fine pellets of water are forced into intimate contact as they travel through successive rows of inclined reversed baffles. The water from the second stage on top discharges through the lower stage, consisting of alternating offset hurdles and rain spaces; the full counter-current effect is obtained and utilized to the greatest extent. Moreover, a maximum reten-



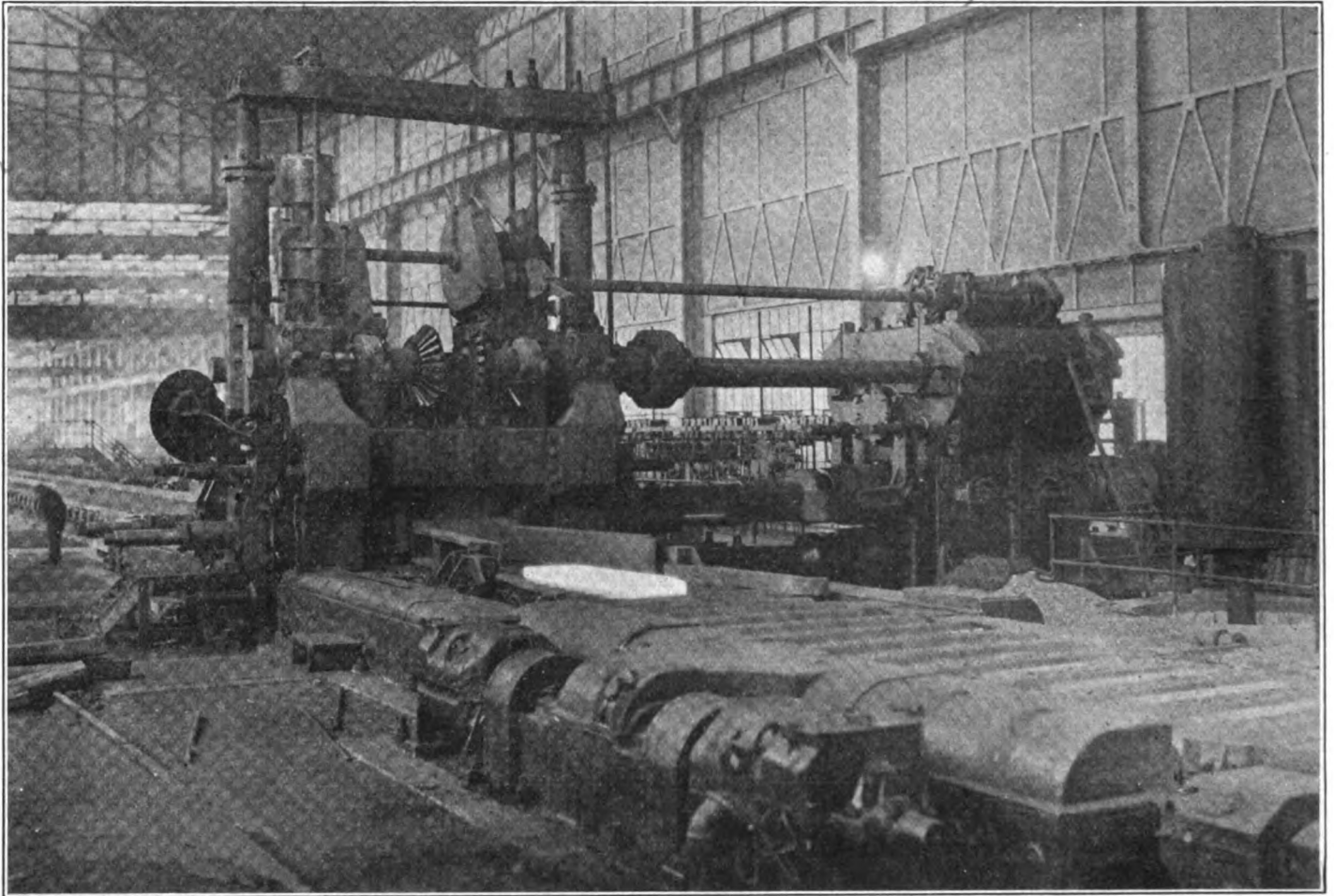
Plan of blast furnace plant, showing complete No. 1 stack and layout of proposed future expansion.

tion period of water within the scrubber is reached.

The application of this type of scrubber at the plant has in itself made possible certain economies in construction cost. Experience has demonstrated that the gas is clean enough so that but three stoves need be built per furnace, and that checker openings as small at $3\frac{1}{2}$ inch are satisfactory, and that both stoves and washer will remain clean and in operation throughout an entire blast campaign and longer. In fact, with but one exception all modern furnace plants in America having but three stoves and using washed gas are operating on Brassert washers. Similarly at Mark, putting the plant on a three-stove basis has

and mixed gas and chain grate firing on the remaining four Stirlings. It is believed that this is the first instance of combined blast furnace gas and chain grate stoker firing on heavy mill loads. For this particular case where the boilers have to be kept at a high overload on rating and capable of maintaining an effective rate of heat transfer for sudden pick-up of load, and where as many boilers as possible must be kept on the line, clean gas has been of inestimable value, both in keeping settings and tubes clean, and in keeping in service with minimum cleaning and loss in efficiency and capacity.

Foundations and piling for the plant were con-



General view of 30-inch universal plate mill.

resulted in a notable saving in stove equipment, including shell, lining, trimmings and foundations.

Clean gas is also used at the boilers, of which there are six. These are 600 hp Stirling boilers with four pass baffling. Four of the boilers are equipped with Continental chain grate stokers and two have herringbone grates. All six boilers are each equipped with four Birkholz-Terbeck gas burners. This battery of boilers is supplemented by six Casey-Hedges 600 hp boilers, equipped throughout with Continental chain grate stokers. These boilers carry the mill and furnace load with straight gas firing on two Stirlings, straight chain grate coal firing on the Casey-Hedges,

constructed by James O. Heyworth; platework was fabricated and erected by the Pennsylvania Engineering Works; bins, bridges and unloaders by Hoover and Mason; skip incline and cast house structural work was by the Pennsylvania Bridge Company; piping by the Pittsburgh Piping and Equipment Company; engineering by Freyn, Brassert & Co., and supervision of erection jointly by Freyn, Brassert & Co., and Messrs. Clarence Mark, vice president; A. H. Beale, general superintendent, and A. O. Baer, blast furnace superintendent for the Steel and Tube Company of America, at Mark plant.

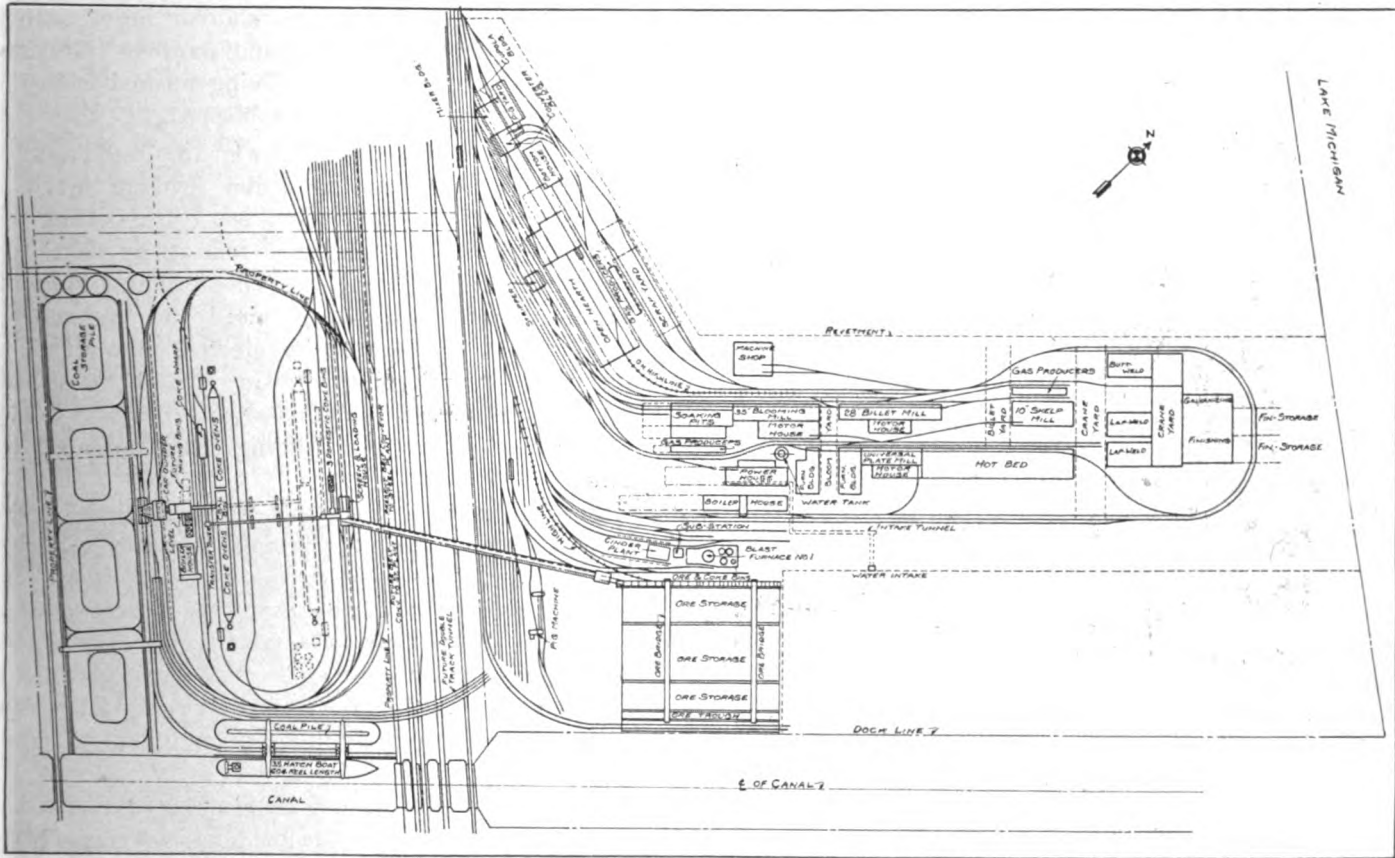
Electrical engineers of steel plants will be particu-

larly interested in the illustration on the next page which shows two Dean valve controls on the delivery side of the blowers which supply air to the blast furnace.

The air for the blast furnace is supplied by two Ingersoll-Rand five-stage turbo blowers, rated at 4,000 hp with a speed of 2,250 to 2,800 rpm and an air delivery of 34,400 to 55,000 cubic feet per minute, at 14 pounds pressure. The air is taken in through two 72-inch intakes; the screened top of one of them can be seen in the illustration. The two discharge lines are 36 inches in diameter and lead from the blowers in the power house to the main discharge

36-inch discharges lines with the valve control stations located near the turbine throttles. With this equipment the engineer can start the turbine and then, by merely placing the handle of the valve control station in the open position, open the corresponding discharge valve. This convenient and speedy control is especially desirable when changing from one turbine to another. The importance of being able to open and close these two valves rapidly will be appreciated when one remembers that blast furnaces are very seldom shut down a turbo-blower.

The Dean valve control is made by the Cutler-Hammer Company of Milwaukee and New York. Primarily, it consists of a high torque squirrel cage



Layout of blast furnace, ore storage, rolling mills, coke ovens, open hearths, etc.

line just outside. There are two 36-inch gate valves located at the point where the 36-inch lines enter the 48-inch main discharge line.

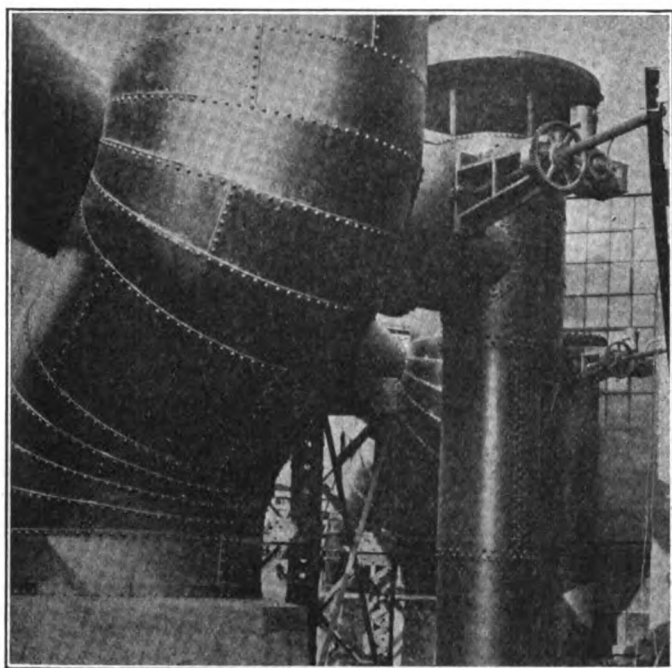
From the illustration it will be seen that the valves are placed approximately 15 feet above the ground, hence they would be very inaccessible to operate by hand, besides it would be very inconvenient to operate the steam throttle on the turbo blowers and valves simultaneously. At least two attendants would be required to close the throttle of the turbine and the gate valve at anywhere near the same time. In order therefore, to make the operation of the valves convenient and to guard against any serious irregularities of the air flow to the blast furnace, two Dean valve controls were installed in the two

motor limit switches with special gear arrangement and one or more control stations.

The Dean system is entirely electrical in operation, using a fully enclosed motor, as the source of power. This motor runs at a speed of about 1,600 revolutions per minute and is connected to a system of combined worm and planetary gearing for the purpose of speed reduction to the valve stem. The gearing is enclosed in an oil-tight casing and the limit mechanism is included in a space above the gearing, the whole, together with the motor forming a single unit with only four bolting down holes. All cables from the motor to the limit switch are encased in steel conduit and the unit is as impervious to moisture as it is possible to make it. The motor is easily remov

able from the casting and can be changed in a few minutes.

The weak feature of most electrical valve controls is the inability to securely seat the gate under all conditions, caused by the motor circuit being interrupted before the limit of travel is reached and the gate being allowed to drift into its seat. This drift is a most uncertain quantity and it is dependent on friction of the moving parts. The Dean system drives the valve gate directly into the seat, under power, and to the exact point of tight closing, after which the trip mechanism releases the motor and gears from the valve stem, thus entirely eliminating over-travel, due to momentum of moving parts. It is this momentum that is the cause of jamming the gate.



Dean valve control for blast regulation.

Control of the valves is secured by small control stations, placed in heavy cast-iron boxes suitable for attaching to a wall or floor standard; and as many points of control as is desired, for one valve, may be obtained, at any distance from the valve. Each station is fitted with indicating lights showing the position of the gate.

The application of the Dean system to an existing standard gate valve is accomplished by furnishing a new yoke and a pair of driving gears and may be installed without putting the valve out of service. It is particularly adaptable to valves of the outside screw and yoke type since pads for the support of the unit may be welded onto the existing yoke.

30-inch Universal Plate Mill.

The mill has horizontal rolls, 30 inches in diameter by 88 inches long. It is of the latest design embody-

ing a number of exclusive features. The vertical rolls will permit of rolling universal plate or skelp varying in width from 8 to 42 inches. The connections between the pinions and rolls are made with their patented universal couplings. The pinion housing is totally enclosed. The pinions have double helical cut teeth and run in oil; bearings are arranged for continuous lubrication. The gears for driving the vertical roll shafts are driven from the main and mill pinions and are contained in the same housing.

The mill is served by four side door regenerative heating furnaces. They are arranged on either side of the slab yard, the slabs or ingots being taken from the yard and charged into the furnaces by electric overhead charging and drawing cranes. These machines also load the heated slab or ingot onto a motor driven buggy which runs parallel with the mill tables, the ingots or slabs being pushed from the buggy directly on to the mill tables.

The plates are delivered from the mill onto a runout table and through a roller leveling machine onto the runin table of the cooling bed. The cooling bed consists of substantial supports resting on cast iron stands, the plates being conveyed on chains running in grooved guides which are raised and lowered by levers and shafts operated by electric motors. The plates are first conveyed to the side straightening bed, which consists of a continuous arrangement of heavy cast iron bed plates with sliding jaws operated by screws.

The cooling bed is of ample width so that by the time the plates reach the runout table they are cold enough to be sheared to length, which is done in a standard cutting off plate shear, the lengths being conveyed from the shear by a table, to the castor bed, where they are inspected and piled for loading. In addition to the cutting off shear, the castor bed is also furnished with a side trimming shear to take care of sheared plates, etc.

The skelp is not transferred across the cooling bed; it is delivered from the cooling bed runin table to a cutting off shear onto a table through pinch rollers into a skelp piler.

The building is extended a considerable distance beyond the shears in order to provide ample room for storage and shipping.

All of the tables are equipped with self lubricating bearings. All gears are steel casting with cut teeth, with a view of obtaining the highest efficiency in operation with low cost of upkeep. In fact, the entire operation of this mill and equipment is practically noiseless.

The layout is arranged to take universal mill plates up to 150 feet in length. In addition to rolling universal plate and skelp, the entire layout has been made so as to permit of the rolling of sheared plates up to 80 inches in width, which makes a very flexible operating proposition.

Heating and Preheating Forging Furnaces

Recent Installations of Sturdy Construction Designed to Withstand Distorting Action of Heat as Well as Wear—Combustion Chambers on Preheating Furnace Staggered on Each Side.

During the past few years, as never before in the history of this country, the demand for heavy forgings has almost overwhelmed the trade. The tonnage of steel consumed in this branch of the business has gone up by leaps and bounds, compelling the various forge shops to treat their particular allotments with the greatest care and to use every effort to prevent the loss of even a single ingot.

A poorly heated ingot causes trouble all along the line and generally winds up its career among the outcasts of the scrap pile. Because of this, we should give much consideration to the forge furnace.

The accompanying sketches and photographs were furnished by W. W. Lindsay & Co., Inc., engineers and contractors, of Philadelphia, who have during the year 1918 designed and constructed a number of these furnaces.

Figure 2 shows a sectional view of a compact type of furnace used for heating ingots for a forge press. The binding is simple in arrangement, but of sturdy construction, to stand up against the distorting action of heat as well as the hard bumps that such a furnace almost

invariably receives when heavy ingots are handled rapidly.

The roof is carried independently of the side walls by means of heavy skewback channels which are braced

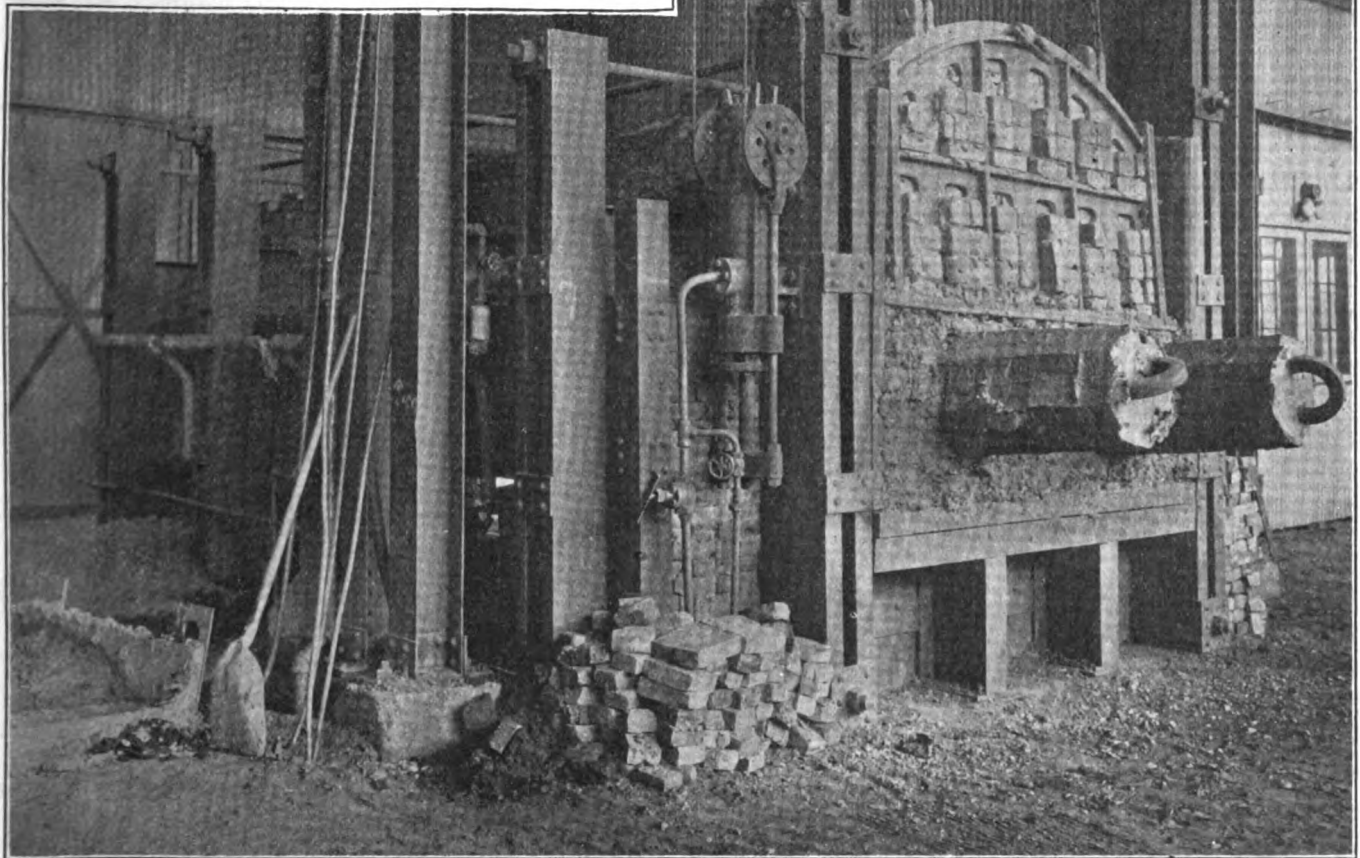
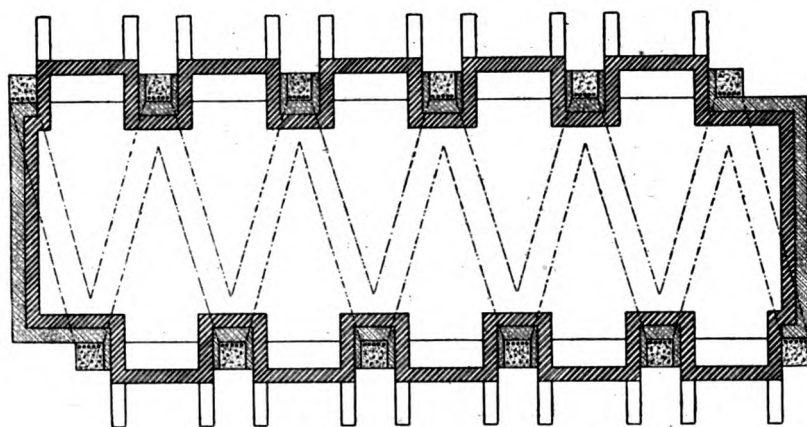


Fig. 1—High temperature heating furnace with ingot inserted and walled in.



the heat of the waste gases passing out through the openings in the roof. A pivoted damper on the burner plate regulates the air supply.

The rear wall of the furnace is provided with a brick-up doorway, to be used when the middle portion of an unusually long forging is to be heated. The front door is of cast iron protected by a firebrick lining, and is operated by means of a hydraulic cylinder mounted on one of the front buckstays. As the bottom and side edges are the only portions of the door subjected to much hard usage, either from shock or the action of the heat, these parts are made of cast steel and are removable.

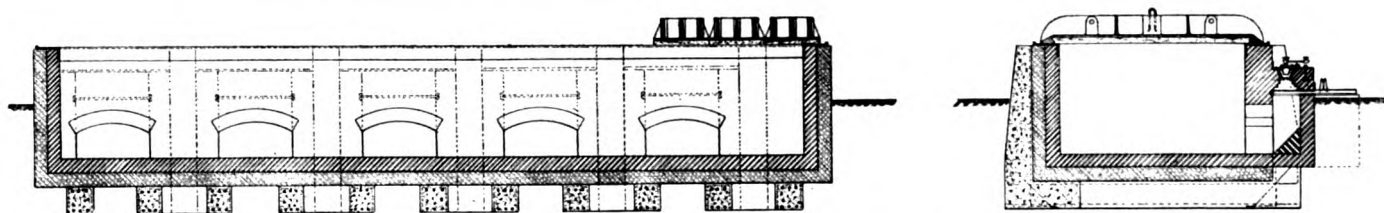


Fig. 2—Sectional views of open top low temperature preheating furnace.

by struts to the buckstays. The holes shown in the roof, near the skewbacks, permit the escape of the gases of combustion.

The side walls each contain three combustion chambers. As originally designed, none of the brickwork extended beyond the inner face of the buckstay, because of clearance requirements in the very limited building space allotted to the furnace. In practice, however, it was found feasible to move the outer walls back to the outside face of the buckstay, thereby obtaining larger combustion chambers and, at the same time, eliminating the scouring action of the flame when it impinged on the bridge wall at short range.

The fuel oil is blown at the side, as indicated. Either compressed air or steam may be used for atomizing the oil. When the atomizing agent is steam which has been piped a considerable distance, it can be dried by utilizing

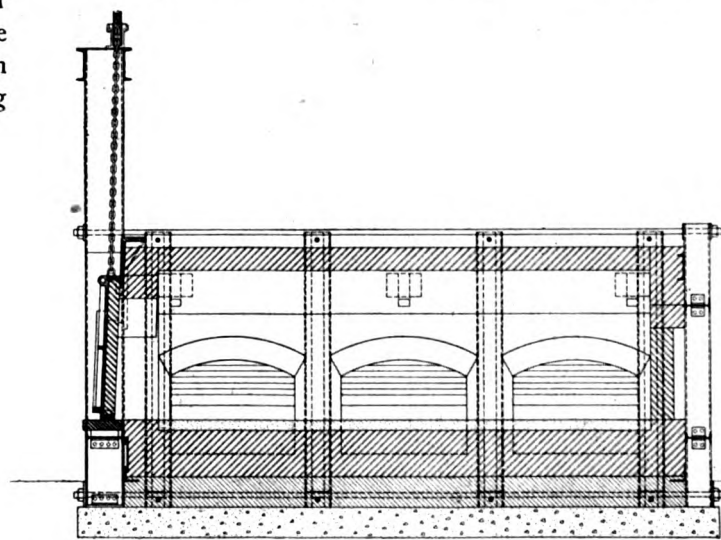
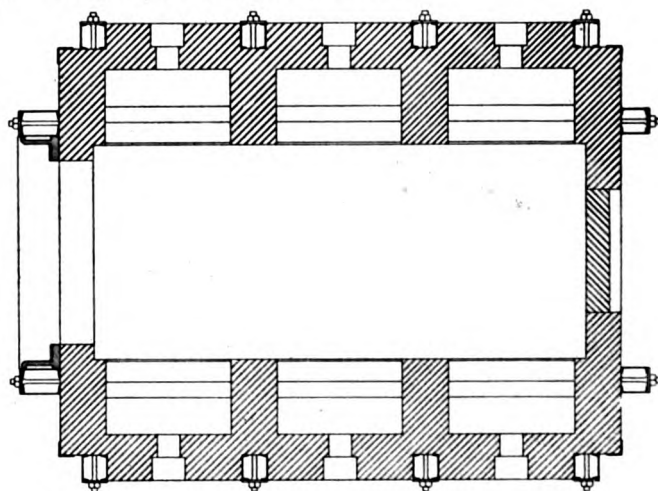
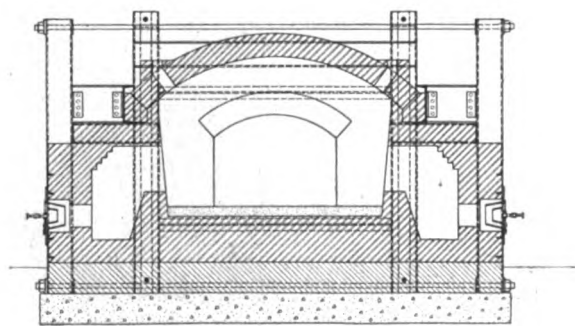


Fig. 3—Sectional views of a compact type of high temperature furnace for heating ingots for a forge press.

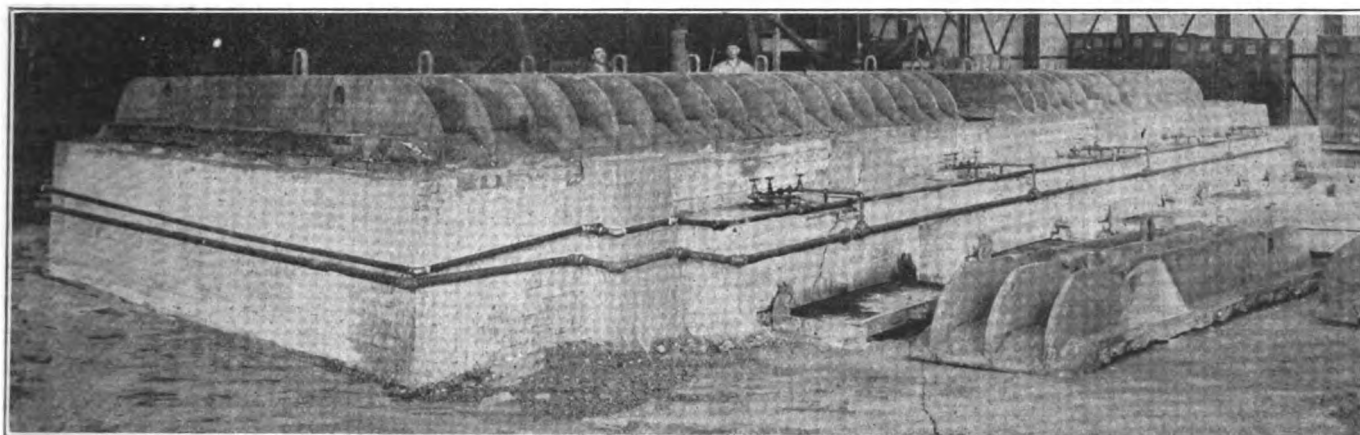


Fig. 4—Low temperature preheating furnace. Removable section shown at the right.

of 2,500 deg. F., a considerable saving in time can be made by preheating the ingots to about 1,400 deg. F., in another furnace, because, if cold ingots are used, the high temperature furnace must be cooled in order to avoid injury to the steel. The somewhat heroic treatment frequently used for hastening this cooling process can hardly be said to benefit the brickwork (to say nothing of the waste of heat) and for this reason if for no other, a preheating furnace should be used.

Such a preheating furnace of the open top type is shown in Figure 2. It is built partially below the floor line for convenience in operating and to save head room.

The side walls are stiffened by a series of reinforced concrete U clamps or buckstays and are protected on top by a cast iron curbing which also helps to align the roof sections which are removable. These sections are of cast iron, heavily ribbed on top and have a thick coating of clay on the bottom for insulating purposes.

The fuel oil is blown vertically downward against an inclined baffle wall which deflects the flame into the body of the furnace, while the air-regulating arrangement is similar to that of the high temperature furnace. The combustion chambers on opposite sides are staggered, to distribute the heat more uniformly and a slide damper is placed in each chamber, below the burner, to prevent the escape of the heated gases whenever it is necessary or desirable to shut off any particular burner.

As the temperature does not exceed 1,400 deg. F., heated ingots may be removed from this furnace to the high temperature furnace and replaced by cold ingots without waiting for the brickwork to cool.

The accompanying illustration Fig. 4, shows an exterior view of one of these preheating furnaces that serves a battery of high temperature furnaces, one type of which is shown in Fig. 1. One of the removable roof sections of the preheating furnace can be seen at the side, lying on the floor. These views give a good idea of the appearance of the furnaces under working conditions, with the ingots inserted and walled in below the raised front doors.

MODERN OIL HOUSE.

(Continued from Page 49)

passes to the pumps and through a 3-in. pipe line to the tank. A meter is placed in the line between the car and the pump, which registers the amount of oil drawn from the car. Oil for distribution is handled through the same pipe line, back to the pump, in the discharge line of which is an automatic registering cut-off meter. This meter can be set to deliver any desired quantity, at which time it automatically cuts out the motor on the pump. Each tank is equipped with its own individual pipe line and pump, there being nine pumps and nine pipe lines for the nine tanks.

A similar arrangement is provided for the 1,500- and 2,500-gallon tanks, a pump being provided in the storage room by which oil can be taken from tank wagons and pumped into the proper tanks. Only one pump is provided, however, for this service, the different pipe lines being all connected to the one pump so the oil can be sent into its proper line by the opening of a valve and the closing of the other valves. The return of the oil for distribution from the tanks is handled by the ordinary type of hand pump in the service room. All of this power pump equipment was furnished by the S. F. Bowser Company, of Fort Wayne, Ind.

The service room is also equipped with six 10-barrel rectangular storage tanks into which the contents of barrels can be emptied from a track running on the top of the tanks. These tanks are equipped with the ordinary hand type of pump. These were also furnished by the Bowser company.

The storage of benzol and gasoline is provided for by a 550-gallon tank for benzol and a 1,500-gallon tank for gasoline, which are buried outside of the building. The distribution of these is done entirely outside of the building, the pumps only being on the inside; piping from the tanks to the pumps and from the pumps to the distributing head being entirely outside the building.

A steam heated rack is provided for grease barrels in the service room from which grease or the heavier oils can be measured in such quantities as desired.

Movable Car Dumper with Rotary Cradle

Machine Located Near Storage Yard for Economical Handling of Ore and Limestone at Blast Furnace Plant—Capable of Unloading Thirty to Thirty-five Cars an Hour.

By A. F. CASE,
Engineer, Wellman-Seaver-Morgan Company.

The ore and limestone for the Brier Hill Steel Company blast furnace plant arrive by rail in open top road cars, which must be quickly and economically discharged. For this purpose a movable car dumper built by the Wellman-Seaver-Morgan Company is employed. The only function of this machine is to discharge the contents of the cars within reach of the rehandling bridge which stores the material or rehandles it for furnace use as required. The car dumper is located next to the storage yard and is so arranged that it discharges the contents of the road cars beyond the wall bounding the storage yard. It is mounted on wheels which travel on runway rails laid parallel to the yard. The arrangement and locations of these runways is shown in the accompanying cut.

The machine is a massive structure, carrying a rotating cradle in which the road car is held while dumping. The cradle is arranged to rotate, about pivots supported in the front part of the main structure, until the car is inverted to an angle only 20 degrees from the vertical, discharging the contents of the car into storage yard. It is necessary, of course, to hold the car firmly in the cradle, prevent it from falling when the cradle is inverted. This is accomplished by a system of clamps, four in number, which are hinged to the cradle and operated by ropes attached to heavy counterweights operating in guides at the rear of the machine.

The cradle is rotated by a simple mechanism, located in the enclosure at the top of the machine, to which connection is made by ropes, as will be described later. It will be seen, from the cut, that the runways of the machine are on either side of the track upon which the road cars travel, and also that the car, when in the dumper, stands on a track, elevated about three feet above the yard track. This elevation is necessary in order to provide room for the framework of the cradle. In order that the cars may be elevated this short distance, inclined tracks are provided, attached to each end of the machine, which travel with the machine and lead from the level of the yard tracks to the level of the tracks in the cradle. Cars are pushed up this incline by means of a locomotive and after they are discharged they are pushed out of the cradle by the next loaded car and run down the incline, at the opposite end of the machine, to the yard track.

The rails in the cradle are carried on a platen which is capable of transverse movement. When the cradle is in its normal position the rails on the platen register exactly with the rails on the inclines, but as soon as the cradle starts to rotate, the platen moves toward the dumping side of the machine until the car rests against blocks secured to the side of the cradle and in this manner is supported while being discharged. Upon returning to normal position the platen moves in the opposite direction until its rails again register with those on the inclines. This movement is required to provide clearance as the car is pushed into the cradle and also to insure support for the side of the car as it is being dumped.

There are four clamps for holding the car in position on the cradle while dumping. These clamps are heavy steel struts, hinged to a hook casting, which slides in guides attached to the front side of the cradle. The hook casting carries a sheave for the clamp ropes, which are anchored to the cradle, and pass over this sheave, thence through the clamp beam and around a sheave in the outer or free end of the beam; passing then over sheaves in the main structure they are attached to the clamp operating counterweights which travel in vertical guides at the rear of the machine. The hook casting is normally held in its upper position by a cam operated device attached to the cradle, and so arranged that the hook is raised as the cradle returns to normal position after dumping a car. The free end of the clamp is suspended in the clamp cable so that its free end is above the hook casting and at an angle of about 30 degrees.

After the car is placed in proper position in the cradle as previously described, the machinery is started and the cradle begins to rotate. As soon as this motion starts the platen moves transversely until the side of the car rests against the cradle, and as the rotation progresses, the clamp lifting cams are released, allowing the hook casting to descend until it rests on the top of the car next to the cradle. The outer end of the clamp is still suspended on the cables but as the cradle approaches a position about 30 degrees from the normal, the top of the outer side of the car engages the clamp beam and the counterweights begin to rise. The counterweights are made in sections which are applied one by one as more counterweight is required in subsequent degrees of rotation. The car is completely discharged as its

final position is reached and is then returned with the cradle to its original position, being assisted in its return by the clamp counterweights.

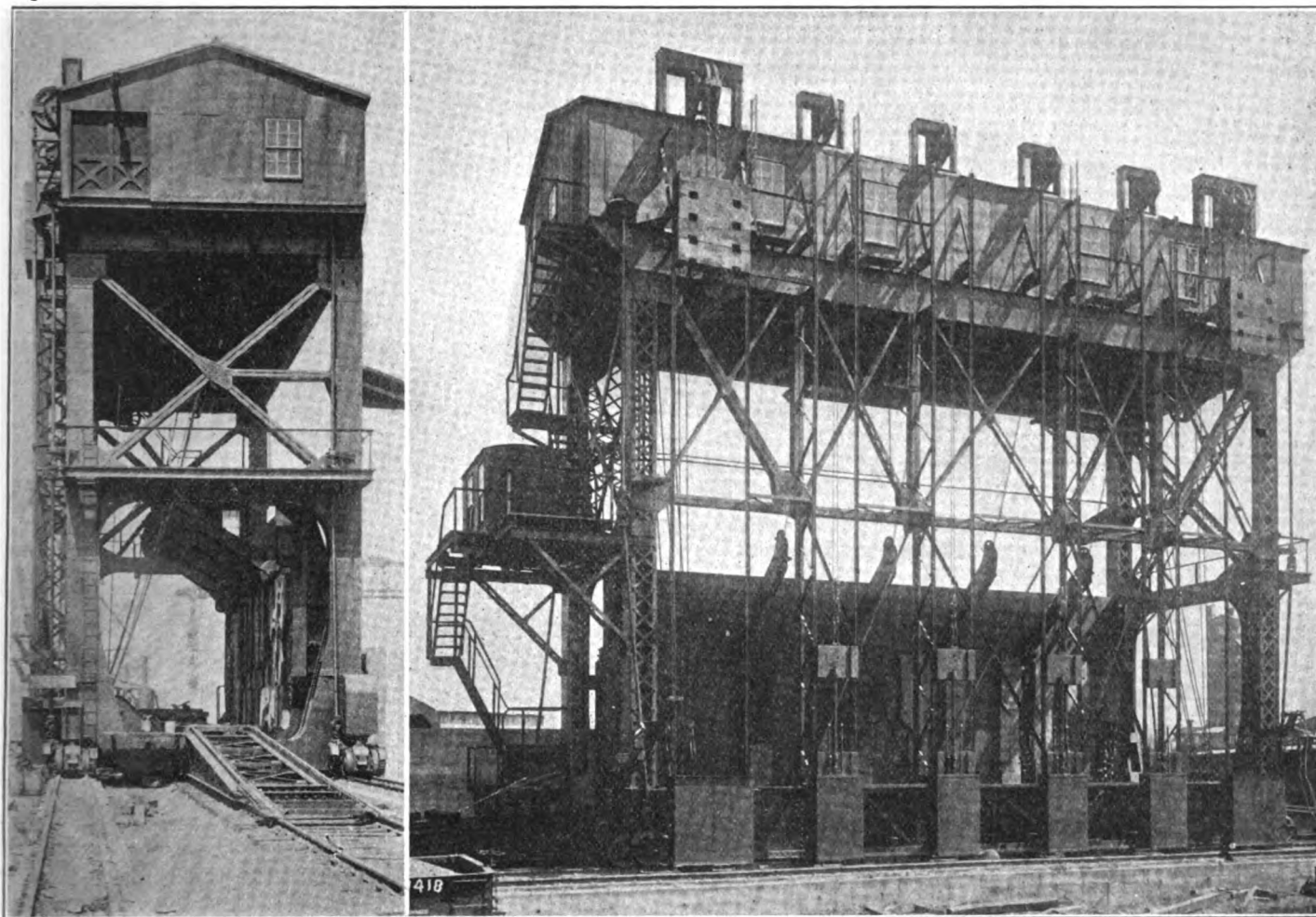
This car dumper is capable of handling between 30 and 35 cars an hour and is automatically adjustable to any size of road car having heights between 6 feet 6 inches, and 12 feet 6 inches, and width up to 11 feet, lengths up to 52 feet, and a maximum weight of car and contents up to 285,000 pounds.

The machinery for rotating the cradle is driven by two General Electric No. 109-A type M. D. S. 170 hp motors, series wound for a direct current of 230 volts.

brakes since they are operative in case of any failure of the current. In addition to the electric brakes, a foot-operated brake is applied to the motor jack shaft.

Four 1¼ in. steel cables are attached to each drum, leading around the back of the cradle and to the front side where they are attached to the cradle frame. As the rope is wound on the drums the cradle gradually rolls out of the hoisting ropes, and is held by the counterweight ropes.

As the cradle returns to its original position it exerts an excessive pull on the cables leading to the drums, which



Two views of movable car dumper.

The motors are geared to the winding drums by three reductions of cut spur gearing. Two drums, located about 47 feet center to center, are geared to a heavy countershaft extending from one to the other, and geared by a second reduction to the motor jack shaft. The shafting is carried in heavy pillow blocks with cast steel sole plates riveted to the machinery floor.

Each of the motors is equipped with a solenoid operated brake on its armature shaft, so arranged as to set instantaneously when the current is cut off. These brakes are entirely automatic and are used ordinarily as service brakes although they are effective safety

drives them in a reverse direction from hoisting. This rope pull must be accurately controlled in order that excessive speeds shall not result in dropping the cradle. The magnetic control board is so arranged that in the reverse direction the armature of the motors are short-circuited through resistance and the motors made to act as generators. The amount of resistance is variable so that it is possible to obtain very delicate control and perfect retardation of the cradle. This application is called dynamic braking and is the most perfect of all lowering controls. As previously stated, the machine is movable, being mounted on trucks which travel on the runway rails.

General Review of Steel Industry for 1918

**Quantity and Character of Output—Alignment of Belligerents.
The Transition to Peace—Labor and Wages—Labor Saving Ma-
chinery to Be Increasingly Favored and Necessitated.**

By B. E. V. LUTY.

The American iron and steel industry made an excellent record for efficiency in the last year of the great war. The "team work" of the producers, their spirit of coöperation, left nothing to be desired, and in actual material performance the results were wonderful considering the many handicaps. The production of ingots, was about 42,000,000 gross tons, compared with a capacity computed against favorable conditions of fully 47,000,000 tons, but at least 2,500,000 tons of output was lost through the traffic difficulties of early in the year, and throughout the year there was tonnage lost through shortage of scrap of good quality, and labor was also very scarce. These were conditions over which the industry had no control. The output compared with 43,700,000 tons in 1917 and 30,300,000 tons in 1913, the year before the war.

Even more remarkable than the quantity of the

tons of sheared plates, $\frac{1}{4}$ -inch and over, although there was a tremendous demand for such plates. What the production was in 1918 is not recorded as yet, but it was probably about double that of 1916. New plate mills were built. Plates were rolled from slabbing mill slabs as usual, but large tonnages were also rolled from slab ingots and blooming mill slabs. Slabs were shipped from steel mill to rolling mill regardless of freights.

A very large tonnage of shell steel was produced, but that performance was not particularly remarkable in view of the two years and more of training the mills had had before the United States entered the war. There were continued improvements in practice, however, whereby rejections were greatly reduced.

Modern warfare is largely engineering, and engineering is largely steel. It would be impossible to chronicle the various means by which steel was used to help win the war. It was used to build ships, docks, warehouses, railroads to and at the front, motor trucks, airplanes, field kitchens, trench covers, shelters and what-not.

Alignment of the Belligerents.

During the time the United States was in the war it had a much greater preponderance over the Central Powers and over its cobelligerents, than was the case before the war started, because from 1913 to 1917 and 1918 the steel production of the United States increased greatly, while the production of some of the belligerents decreased greatly, and none showed any great tonnage increase. In 1913 the United States produced 31,300,874 gross tons of steel ingots and castings, which was 41 per cent of the world's steel production, estimated at a trifle over 75,000,000 tons.

The changes in the balance of steel power between the belligerents is interesting to trace. Assuming a war between Germany and Austria-Hungary on the one side and Russia, Belgium, France and Great Britain on the other, the 1913 production statistics would show about 21,600,000 tons against 20,700,000 tons. Germany, however, at once overran Belgium and portions of France involving three-fourths of the French production, causing a loss of 6,000,000 tons and bringing the Entente down to 14,700,000 tons, even if the works captured did not help Germany. It appears that they were dismantled to a greater extent

In this article Mr. Luty describes in an interesting manner how the balance of power in steel production of the warring nations shifted several times during the war. The factors which influenced this shift of balance are traced from the time the German invasion in 1914 reduced the Entente steel capacity by six million tons until the entrance of the United States gave the final lead to the Allies and threw the steel production capacity three to one against the Central Powers.

output was its character. The United States is the home of the specialty or specialized mill. The character of the output had been regarded as rather inflexible, each finishing mill having its own line with the sum total of finishing capacity not greatly exceeding the steel producing capacity, say by 20 per cent. In 1916 and 1917 there had been large increases in open-hearth capacity, without corresponding increases in rolling capacity, thus apparently reducing the flexibility of the industry. Nevertheless the industry was able to respond fully to the curious and peculiar demands of the war.

The most astonishing performance was in plates. In 1916 the country had produced only 1,865,000 gross

than they were operated. In May, 1915, Italy joined the Entente, adding 1,000,000 tons, and thus theoretically the alignment stood 21,600,000 tons for the Central Powers and 15,700,000 tons for the Entente. Entente orders for steel from the United States became heavy, and our steel exports to Great Britain, France, Italy and Russia in 1916 amounted to more than 5,000,000 tons, reduced to the ingot basis, so that, superficially, the balance was restored. German production of steel, however, went down from 19,000,000 tons in 1913 to 16,000,000 tons in 1916, while Austria-Hungary's production increased some 600,000 tons to 3,300,000 tons. This made a net loss to the Central Powers of say 2,400,000 tons, minus such production as may have been secured in occupied territory. Great Britain's production increased from 1913 to 1916 by 1,500,000 tons, and the French installed some new capacity, about which there is no detailed information. The new capacity may be guessed at between 500,000 and 1,000,000 tons.

Thus we have the turns in the kaleidoscope somewhat as follows: Starting at 51 to 49 in favor of the Central Powers the overrunning of Belgium and part of France made it apparently 60 to 40 for the Central Powers, and then the entrance of Italy plus the Entente's supplies from the United States made about a 50-50 division, on the basis of capacities. On the basis of actual production, with the reduced output of the Central Powers and the new British and French capacity it became 53 to 47 in favor of the Entente. That was not all. Russia fell down, and as Russia had contributed 4,800,000 tons to the 1913 production and had made a trifle more in 1915 (there are no figures for 1916) the balance was turned against the Entente again, to the extent of 48 to 52, assuming that Germany gained nothing by Russia's defection.

The figures available are of course not absolutely complete, but they show roughly that at the time the United States entered the war, counting Russia out, there was a shade over 20,000,000 tons of ingots being produced by the Central Powers and a trifle less than 14,000,000 tons by the Entente, which was being reinforced by supplies from the United States, representing somewhat more than 5,000,000 tons of ingots a year. The United States produced 43,700,000 tons of ingots in 1917, with perhaps 1,300,000 tons of castings, making 45,000,000 tons of steel, so that, deducting the supplies already furnished, it threw nearly 40,000,000 tons of steel into a contest that was being waged with a trifle over 20,000,000 tons by the Central Powers and a trifle less than that by the Entente. Thus it became something like 60,000,000 tons to 20,000,000 tons, 75 to 25.

Of course it may be said that the steel did not count in anything like that proportion because it did not appear at the front. Most of the American steel had to stay at home to keep American industries

going, but those American industries were helping to win the war. The railroads were supplied with steel, and transported war material, to the exclusion when necessary of unessential freight movement, and in various other ways steel that did not get to the front rendered its service just the same.

The Transition to Peace.

Now the war is over and it is not especially important to consider in detail the various services that steel rendered in the war, for we are to have no more wars. The industry is in the transitionary period from war time to peace time conditions and before it, after this transitionary period, after the readjustments and rearrangements have been made, lies what practically everyone believes will be a period of several years of great prosperity and activity; Judge Gary ventures to predict the duration at five years. During the war steel was unobtainable for purely peace purposes. The system of distribution to which the last finishing touches were put in July 1, 1918, prescribed AA priorities, A priorities, B priorities, Class C or "preference" steel and Class D or "permit" steel. Class C was steel destined for purposes that would indirectly help win the war. After the priorities were taken care of there was little steel left for the preference list. It absorbed what was left and

In considering the problems of the steel industry caused by the transition to peace the author particularly points out why the "barometer industry" is vitally concerned with the labor and wage conditions of other industries. He also shows that whereas prior to the war the population of this country was increased by approximately 60,000 per month, that it is quite possible that future passenger movement may for a time cause a decrease in population rather than an increase.

there was no steel to fall in Class D, which represented steel that might be distributed for purposes given no recognition in connection with the war, provided the director of steel supply gave a written permit for its manufacture and shipment. There were practically no such permits.

In the circumstances, one might suppose that the end of the war would find such a famine in steel that there would be a rush to buy. That did not occur, and there was no reason to suppose it would. A starved man must not eat a square meal. He must get his digestion in order again. He needs only a little food to supply energy, but a great deal to build up tissue, and all the bodily functions must be made

to perform well before the tissue building can proceed at any speed.

Dropping the simile, it must be remembered that steel is used very largely for construction purposes. The tin can is consumed like food, but the canning season is over. Steel is made into tools, household utensils and various implements and the demand along such lines has suffered little if any break, being in many instances augmented. The automobile builders began calling loudly for steel the moment the War Industries Board removed the restrictions on automobile building, but it takes time to put the steel through the various processes. Nearly all has to be made to specification in the open-hearth furnaces.

Beyond all this, however, lies the major portion of the total steel normally consumed, used in strictly construction work or for investment purposes. The steel is not consumed currently, but is put into employment. An investment is made. The investor buys steel, other construction materials, and labor. He expects a profit year by year on his investment, and the eventual return of his capital, in a period of 5, 10 or 15 years, depending on the nature of the investment, whether it can be counted upon to be profitable for a longer or a shorter period. The investor looks to a period of years. If he counts upon a 10 per cent investment, and can save 10 per cent by waiting six months, he is better off by waiting. In any event he requires time to study his problem and draw his plans, no matter how little uncertainty there is as to the fluctuations in the total cost of the investment. At the close of a great war with its great dislocations and the new viewpoints it produces, everything must be studied afresh. In an investment that involves steel, the cost of the steel and the cost of putting the steel into employment, buying the other materials necessary and paying the labor involved must be considered. The cost of steel may be satisfactory to the investor and the cost of putting the steel into employment may be quite unsatisfactory. Stone, sand, cement, lumber, other things, may be too high priced. Wage rates may be too high, or the day's performance too small.

Thus there is a **transitory period** from war time to peace time conditions, in which adjustments occur so that it becomes desirable to the investor for him to invest. Practically all prices were marked to come down more or less. Recognizing the conditions the iron and steel industry's sentiment crystallized in the second week in December in the making of general, though not heavy, reductions in prices, \$3 a ton in pig iron and in finished steel products a schedule that reduced the average price level by between 5 and 6 per cent. The old, or "government" prices could have been maintained for a time but the inception of the readjustment would be postponed, and one object of the iron and steel industry's readjustment in prices

was to set an **example** to other sellers of material, for it is plain that the investor, who buys at least half the steel, will not take hold until everything he must buy has come down as much as he thinks it is going to come down.

If lower wage rates are to come eventually, the steel industry would like to see the condition obtain at once, but it is interested no more in its own wage rates than in the wage costs of the industries that consume steel. The cost of a finished article involving steel, whether a mile of railroad track, a highway bridge, a carpenter's brace, a wheelbarrow or a hot water heating system, depends upon the cost of the labor involved in converting the steel bought from the steel mill into the final article as well as upon the cost of the steel itself. The ultimate buyer or investor considers simply the total or final cost. If the wage cost of fabricating steel or putting it into employment is too high the demand for steel is interfered with. In many cases the wage cost of putting steel into employment is greater than the wage cost of making the steel.

Any reductions or readjustments that may occur in wage rates as a result of the war ending are likely to affect the cost of fabricating or employing steel more than the cost of making steel. The service rendered for a day's pay is likely to increase, and particularly so in the case of construction work. Such changes will encourage the consumption of steel and increase the demand.

At coke works and blast furnaces and in steel mills there has not been the reduction in the quantity of service rendered for a day's pay that has been observed in many steel consuming activities, and not much readjustment has been needed. Much of the labor, moreover, is piece work. The basis rates are very high, more than double the rates in 1915, those rates in turn having represented a large advance over rates in 1898, the last year of the prolonged industrial depression. It does not follow that these rates will come down. There may be material declines in rates of wages paid various artisans, employed in machine shops, foundries and in the building trades generally, as well as the common labor employed with the skilled labor, without wage rates declining materially in the iron and steel industry proper, and this by reason of the particular circumstances surrounding labor conditions in the industry. The coke works, blast furnaces and mills have recruited their labor largely from the foreign born, who naturally gravitated to such employment, partly because they did not mind the noise, dirt and long hours so much as the American born, and partly because ignorance of the language was less of a handicap than in many other employments. It is a case of demand and supply, and the supply has been shut off, as witness some very simple figures. During the period of two fiscal years ended June 30, 1914, the average excess of arrivals over departures in the passenger movement was almost precisely 60,000 per month. From July 1,

1914, to June 30, 1918, four years, the population of the United States should have increased, through the passenger movement, by 2,880,000 if the former rate had been maintained, and that it was not a forced and unusual rate is indicated by the fact that the first of the two years mentioned was one of industrial activity and the second one of industrial depression. In the four years, however, the population increased through the passenger movement by 287,897. Thus to July 1, 1918, there accumulated what may be called a deficit of 2,600,000. Immigration has not started again and is not likely to amount to much, while many foreign born in the United States have expressed the intention of returning to their native lands.

Somebody must do the work, for steel is so valuable intrinsically that it must be made. If there is not enough labor available under given conditions, hours of labor must be shortened or rates of payment increased, to attract men of other classes than those who have hitherto

operated the plants. The 12-hour shift, where employed, may yield to an 8-hour shift. If so there will be an increase rather than a decrease in the hourly rate of wages.

A new relation is thus established between the cost of labor saving machinery and the cost of the labor it displaces. There is more incentive than formerly to introduce labor saving machinery, and undoubtedly the iron and steel industry will see much more installation of labor saving devices in the next five years than in any previous five years in its history. There is not only this important incentive, there is also the unusual fact that the blast furnaces and steel mills have the capital with which to make improvements, on account of their large earnings in the past three years, while on account of the increase in the industry's capacity there is no incentive to invest capital in increasing capacity. It will be invested to reduce operating cost. Thus there is a double incentive for the introduction of labor saving machinery and devices.

Metallurgical Investigations During 1918

Production of Ferromanganese—Smelting Low Grade Manganese Ores in Electric Furnace—Use of Low Grade Iron—Manganese and Other Problems Studied by Bureau of Mines.

By VAN H. MANNING,

Director, United States Bureau of Mines.

During the calendar year 1918, the Federal Bureau of Mines has given much the larger part of its time to the study of problems relating to the production and utilization of those minerals and mineral products that were most needed by the industries of the country in enabling our fleet and armies to do their utmost toward bringing about a victorious peace. Consequently the bureau temporarily laid aside many investigations which had been in progress, began new ones of immediate importance, and built up organizations of engineers and chemists particularly qualified for undertaking the new work. These changes affected investigations relating to mining, mineral technology and petroleum technology, as well as those dealing with metallurgy.

Inasmuch as about 88 per cent of the total output of iron ore in the United States is produced in the Lake Superior district, comprising the states of Minnesota, Wisconsin and Michigan, the Bureau of Mines in 1917 planned to conduct its iron ore investigations chiefly at its Lake Superior station, which was established that year at Minneapolis. The problems to be investigated at this station include the concentration of sandy and cherty hematites, of lean magnetites and of titaniferous magnetites, and also the concentration of magniferous ores.

Because the steel industry of the country needed at once a large supply of manganese alloys, and as im-

ports of manganese ores used in making high-grade alloys had to be curtailed by the need of ships to transport troops and supplies to Europe, the problem of obtaining a sufficient supply of usable domestic ore became of pressing importance. For this reason the Lake Superior station was instructed to give all its attention to manganese, and especially to the concentration and beneficiation of low-grade ores. At the beginning of the new fiscal year, on July 1, 1918, the work on manganese, as related to the war minerals investigation being conducted by the Bureau of Mines, was greatly extended and put in direct charge of C. M. Weld.

During 1918 members of the bureau examined manganese deposits in many states, in Cuba, and in Newfoundland; studied the possible improvement in mining and beneficiation methods in the South and the recovery of manganese from the manganiferous silver ores of the Leadville district, Colorado; and took up the study of new metallurgical methods or of possible changes in present steel works practice with a view to widening the market for domestic ores. In addition to making these investigations of manganese, the Bureau of Mines in 1918 studied the possibility of producing special steels in the electric furnace; assisted in an investigation of the cause of "woody structure" and of "flakes" in nickel steel; examined chromite deposits and investigated the production of ferro-

chrome; began through its ceramics station at Columbus, Ohio, an investigation of the possibility of substituting domestic graphite for foreign graphite in the manufacture of crucibles; and continued an investigation of the possibility of recovering potash from the dust of blast furnace. Some of the investigations were merely preliminary, being largely confined to the collection of data needed as a basis for further work. Others were made in more detail.

This review deals especially with investigations relating to the production of ferromanganese in the blast furnace, the smelting of low-grade manganese ores in the electric furnace, and the use of low-grade iron-manganese alloys and of silico-manganese in steel making.

In the course of the work on the smelting of manganese ores in the blast furnace, data was collected from the records of every furnace in blast on ferromanganese in the summer of 1918, except those of two companies, and a large mass of information was gathered at 40 "runs," each of 10 days duration, at 11 different furnaces. The chief purpose in collecting the data and observing the operation of the furnaces was to determine how to lessen the loss of manganese, either at the furnace top or in the slag, and to determine how efficiency could be increased and the cost of production reduced.

The data indicate that in shifting a furnace from pig iron to ferromanganese there is no need of raising the temperature of the blast, of increasing the basicity of the slag or of running with a hotter hearth; but the coke requirement per ton of metal produced is tripled, the proportion of CO in the top gas is increased 50 per cent, and the top temperature rises from 1,000 to 1,500° F., and the daily output of metal is reduced one-third.

The stack loss of manganese ranged from 0.8 per cent to 32.1 per cent, averaging 12.8 per cent. Part of this loss is due to volatilization of manganese and of manganese oxide, part to particles of manganese in the dust, and a part is fictitious, being represented by errors in weighing or analysis. The volatilization loss is not affected by the basicity of the slag, the silicon in the metal, the carbon charged as fuel, the rate of driving, or the temperature of the top gas.

The proportion of manganese in the slag ranged from 7.4 to 14.2 per cent. The most effective method of reducing such loss is to use low-ash coke and low-silica limestone and to keep the slag as basic as possible. At one furnace a limestone carrying 7 per cent silica was used, although an analysis of the burdening of the furnace shows that such stone should not be used even if delivered at the furnace free of cost.

As the blast furnace cannot profitably smelt manganese ores low in iron that run much below 40 per cent manganese and much above 12 per cent silica, and as there are in this country large quantities of

manganese ores lying without these limits, the electric furnace deserves especial attention in times of a national emergency, not only because it can utilize these ores for making silicon-manganese alloys, but also because an electric-furnace plant can be erected more quickly than a blast-furnace plant.

The electric furnaces that were running on manganese in the summer of 1918, ranged in size from 350 to 3,000 kw. Nearly all of them were of the three-phase, three-electrode type, were rectangular in shape with open tops, lined with carbon or magnesite, charged continuously, and tapped every two hours; the slag and metal running into a settler. At a few plants jointed electrodes were used in order to conserve electrodes; at other plants the electrode butts were scrapped. The power consumption was about 5,000 kwh for each long ton of metal produced.

The ores being electrically smelted in 1918, carried 39.5 to 43.5 per cent Mn, 15 to 25 per cent SiO₂, and were low in phosphorus, their average content of manganese was 40 per cent; of silica 20 per cent; and of phosphorus 0.20 per cent. Their iron content was less than 4 per cent. The slag compared with that in blast-furnace practice.

The recovery of manganese averaged 75 per cent, being nearer 80 per cent for ores averaging 15 per cent SiO₂, and nearer 70 per cent for those averaging 25 per cent SiO₂.

The loss of manganese in dust and volatilization was one-sixth to one-third of the conversion loss, and slag losses account for the rest. In blast furnaces smelting low-silica ores the losses are exactly reversed, the slag accounting for only a sixth or a third, and the rest being due to volatilization and dusting.

Efficient utilization of high-silica ores demands the making of an alloy carrying 15 to 20 per cent silicon. Although little silico-manganese has been made in the United States and there has been little demand for it, it is much used in Sweden and France and doubtless in Germany.

In utilizing low-grade domestic ores, those highest in manganese and lowest in silica will naturally be selected first; then those low in manganese but high in silica and low in phosphorus; then similar ores higher in phosphorus; and, lastly, those low-grade ores high in iron. The presence of considerable alumina would not necessarily be detrimental; some of the aluminum would go into the metal where it would act as a deoxidizer and protect the manganese. Silicon-manganese-aluminum alloys with high aluminum are used abroad.

Ore high in phosphorus might be treated by dephosphorizing in one furnace, running with just enough reducer to form MnO, FeO, and P; holding the charge molten for a while to allow the phosphorus to escape; tapping the hot slag into a second furnace; adding an excess of the reducer; and smelting the previously dephosphorized slag.

In regard to the use of manganese in making open-

hearth steel, the investigations of the Bureau of Mines have resulted in recommending three types of practice, as follows:

1. Use of the "molten spiegel mixture" for deoxidation and recarburaization. In this practice the mixture is added in the ladle to steel from which manganese, silicon, and phosphorus has been nearly eliminated in the furnace. At present the practice is limited to the making of steels that contain more than 0.30 per cent carbon, but its use for steel of lower carbon content seems possible under certain conditions.

2. Melting in the furnace to obtain a high residual manganese content, say 0.25 to 0.30 per cent for a final carbon content of 0.10 per cent. This practice presupposes that the steel is made in the furnace and not in the ladle. The alloy added at the end of the heat may be spiegeleisen, unless steels containing less than 0.10 per cent carbon are being made.

3. Use of manganese-silicon alloys. Such alloys are of two classes, high-grade silicomanganese, containing 50 per cent manganese and 25 per cent silicon, and low-grade silicospeigel, containing 50 per cent

iron. The highgrade alloys may be made from the siliceous manganese ores of Montana and California; the lowgrade alloys may be made from the mangani-ferous ores of Minnesota and Colorado.

Silicomanganese can be used in acid open-hearth and electric steel for casting practice; in acid open-hearth steel practice in general, except in the manufacture of the highest grade for ordnance; and in basic open-hearth and Bessemer practice in making steel with a silicon content of 0.10 to 0.30 per cent, when the deoxidizer is added cold in the ladle. There is also the possibility of substituting silicomanganese or silicospeigel for ferromanganese and ferrosilicon in the basic open-hearth process, even when the addition is made in the furnace. It should be noted that the high-silicon alloys contain very little carbon, so that where recarburation is now done by ferromanganese or spiegel, other means of recarburation, such as the use of charcoal, coal, or coke, must be resorted to when silicomanganese is substituted for ferro or spiegel. The low carbon content, on the other hand, would often be a distinct advantage.

Powdered Coal Advance and Development

Failure of Natural Gas Supply Accelerates Powdered Coal Application—Use of This Fuel for Steam Generation—Improvements in Distribution—Control of Fuel—Approximate Installations.

By H. A. KIMBER.

The failure of the natural gas supply in many fields with its constantly advancing price, together with the high price and uncertainty of the oil and coal supply, forced all fuel users to search for some means of diminishing fuel requirements and at the same time securing the advantages of gaseous and liquid fuel.

Powdered fuel, having demonstrated that it was a practical fuel, which could be applied to a wide variety of furnace operations entirely successful, with simple structural modifications, was the logical solution of the problem.

The developments and refinements in the installations of powdered fuel have been in its application to an ever increasing variety of furnace operations. As a consequence, a better understanding has been obtained of the most desirable way to apply the fuel; first, to secure the furnace conditions as regards control of quality of flame demanded by the particular operation to be performed, with the greatest output. Second, to obtain the highest economy in fuel and labor consistent with the foregoing, and which are so sure to result by proper application. In fact the application of powdered fuel is now as well established as is the use of oil or gas.

Powdered fuel in the generation of steam has also begun to show signs of vigorous growth. Although the fundamental principles for its proper application for this use have been known to some engineers for a number of years, which embraces knowledge as to proper furnace proportions and forms, several factors have worked against the large adoption for this purpose, the principle ones being, conservatism, and the much more attractive savings in fuel in metallurgical furnace operations which range from 25 per cent to 50 per cent, as compared with from 10 to 15 per cent savings in boiler firing, the other economies not being understood or appreciated. Coincident with the development of greatly enlarged use of this form of fuel in metallurgical furnaces, and for somewhat the same reasons, it has been forced into the prominent position it deserves, and numerous installations for boiler firing have been made, and are in course of construction. By the application to the combustion chamber design of the principles deduced from actual practice, and proportioning the cubical contents of the firebox to suit all conditions of load and character of fuel to be burned, increased efficiency is secured, due to more complete combustion with little or no excess air, as well as avoidance of slag or soot deposit on the tubes, and lower boiler maintenance.

The ability to carry heavy overloads for long periods, due to the elimination of cleaning fires is also an important point, as are also practical absence of dense smoke, and instant control of steam generation corresponding to varying load requirements. In addition to this, very low grades of fuel had been utilized with practically the same thermal efficiency without increased labor or operating difficulties.

There has been practically no change made in the underlying principles of preparing the fuels for burning, the crushing, drying and pulverizing having become standard in almost all plants. Simplification in design and construction of equipment used however, have been shown, resulting in the elimination of waste, and in bettering working conditions for the operators around the coal milling plants, by the exclusion of floating dust, etc.

It is in the distribution of the fuel however, as well as the more accurate control of the feeding of same to the individual burners, that the progress has been more radical. The earlier plants used screw conveyors for transporting the fuel to the various furnace's hoppers. This method was expensive to install and maintain, as well as very cumbersome. Screw conveyors required excessive power. Within the last year, a number of large installations have been made, in which what is now known as the "Compressed Air Transport System," has been used with great success.

The coal after being pulverized is quickly fed into a steel transport tank, in which the coal is automatically weighed and indicated on a quick reading dial. Compressed air is then admitted, forcing the coal through the transport pipes, (usually three-inch or four-inch diameter), and is diverted by means of special valves, to the various hoppers at the furnaces.

This system has the advantage of low installation cost, can be installed anywhere standard pipe can be run, regardless of bends or obstructions, and has large capacity with very small expenditure of power. This system can cover distances not otherwise possible, successful installations being over 1,500 feet in a single line, and above all handles the fuel as a solid, and not in suspension, the latter being the only condition in which powdered fuel is explosive.

Improvements in the devices for controlling the amount of fuel supplied to each burner have also been marked. In numerous installations a feeder has been installed which has a wide range of capacity, and obviates the necessity of using variable speed drives. This makes it possible to connect feeders to a single source of power with the attendant saving; eliminates the need of dc current where only ac is available or safe, and as the change in feed is effected by turning a hand wheel similar to a gas or oil valve, the furnace heaters readily acquire proficiency in handling and controlling the flame.

The prospects for a further large increase in the

use of powdered fuel are excellent as the high efficiency, reduction in amount and cost of labor, and improvement in output and quality of product where used in metallurgical furnaces, must eventually demand serious consideration by any corporation desiring to maintain its position among competitors.

Editor's Note—To show the diversified use of powdered coal we give below a summary of the furnaces for which pulverized coal was installed during the past year. This list was compiled by C. F. Herrington:

- 175 Sheet furnaces as used in black and tin plate mills.
- 175 Pair furnaces.
- 125 Annealing furnaces, consisting of white and blue annealing in tinplate mills, malleable and steel castings.
- 200 Tin pots, these small furnaces burn on an average of 25 pounds of coal per hour and require a uniform temperature of 600 degrees F.
- 15 Galvanizing pots.
- 50 Heating and reheating furnaces.
- 10 Reverberatory furnaces.
- 12 Wedge roasters.
- 230 Forge furnaces, which includes rivet, nut and bolt furnaces.
- 3 Spring heating furnaces.
- 3 Cathode furnaces.
- 3 Anode furnaces.
- 3 Tin smelting furnaces.
- 8 Copper casting furnaces.
- 2 Casting ladles.
- 1 Converter.
- 4 Magnesite kilns, besides a number of silver and lead refining furnaces.
- 4 500 hp boilers.
- 2 15-ton open hearth.

In addition to the above, pulverized coal has been successfully tried out in annealing seamless tubes of sizes up to and including three inches.

From these approximate statistics the compiler thereof draws the conclusion that pulverized coal has not in the past, and certainly will not in the future be limited in its usefulness to any one or more kinds of operation, as it has been found that wherever natural gas, producer gas or fuel oil can be used in heating operations, pulverized coal can and is being substituted, and with few exceptions found to be more economical as to the cost of fuel; reduces the labor of wheeling coal from cars to the hand fired furnaces besides reducing the fuel consumption from 25 to 50 per cent, and eliminates the cost of handling large quantities of ash, for with pulverized coal a large percentage of ash passes up through the stack along with the products of combustion. Pulverized coal increases the production of the furnace output, reduces the excessive wear on the brickwork, gives a more uniform and penetrating heat, a stronger weld than fuel oil, control of fire is more easily attained than with hand firing and is as simple as either natural gas or fuel oil.

Heating Furnaces & Annealing Furnaces

The First of a Series of Articles Dealing With the Design, Operation and Construction of Heating Furnaces and Annealing Furnaces—Fuel Given Special Consideration.

By W. TRINKS.

PART I.

Furnaces for heating solid steel may, for the purpose of theoretical and practical explanation, be classified in many different ways. One line of division is, however, so paramount as to outweigh all others. I refer to the temperature to which the steel is to be heated. For forging and rolling operations temperatures of 2,150 to 2,250 F. are necessary while for oil quenching and annealing, temperatures from 1,550 to 1,700 F. are required. For tempering of steel (drawing back after quenching), and for annealing of brass, still lower temperatures suffice, viz. 1,200 F. or thereabouts.

The differences in the effects of radiant heat, strength of refractories and metal parts are so marked for the above mentioned temperature values that great differences in design result from them. In consequence, it will be advisable to take up heating furnaces separately from annealing furnaces.

Turning now to the problems which come up in any furnace installation we find almost invariably the following order of procedure:

1. How many furnaces and what capacity or size of each furnace are required for a given output?
2. What fuel shall be used?
3. How much fuel shall be used for the given output?

Bound up with this question is the important problem whether cheap furnaces with high fuel consumption shall be installed, or whether preference is to be given to more economical furnaces with higher cost of installation.

4. How shall the material (which is to be heated or annealed) be handled mechanically?
5. How must the furnace be designed to stand up without excessive repairs?

The present series of articles will attempt to supply the necessary information on the basis of which these five questions can be answered. In taking the questions up in the above order it will frequently be necessary to anticipate information which belongs into the later groups, or to refer back to explanations made in the early installments, because the problems are so bound up with each other that a clean cut separation of them is well nigh impossible.

Furnace Capacity.

The discussion of providing sufficient furnace capacity involves several separate and distinct problems, namely (1) the liberation of sufficient heat within the furnace to heat the material and overcome the

unavoidable losses of heat, (2) the rate of heat flow into and through the surface of the material to be heated, and (3) the flow and equalization of heat within said material.

Rate of Heat Transfer.

Heat is transmitted by conduction, by convection, and by radiation. In the transfer of heat from the fuel gases to the steel or other material, conduction plays so small a part that it may be neglected. Convection is very nearly proportional to the expression

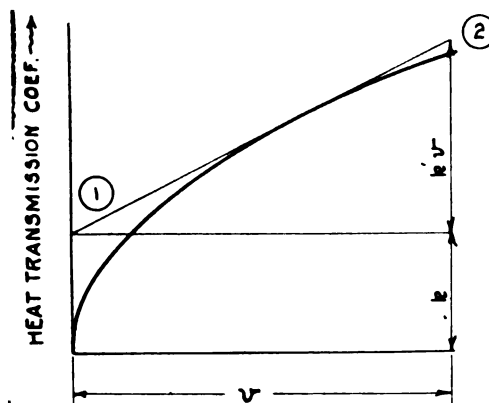


Fig. 1.

Relation between surface temperature of heated material, furnace temperature and time, (without relation to any specific temperature range or any specific material).

$d \times a \times (T-t) \times h \times \sqrt{v}$ where

d = density of gas or flame

a = area of contact between gas and steel

$(T-t)$ = temperature difference between gas and steel

h = time (hours)

v = velocity of flow of gases along steel

The expression $\sqrt{v}$ is somewhat arbitrary, because heat transmission by convection is actually proportional, not to $\sqrt{v}$, but to the expression $k + k^1 v$, where k is caused by diffusion, and k^1 is caused by turbulence of flow. The sum $k + k^1 v$ is represented in Fig. 1 by the straight line (1) (2), while the square root of v is represented by the parabola. It is readily seen that a parabola can be so selected as to almost coincide with the straight line (1) (2) over that range of velocities which is used in furnace practice.

Heat transmission by radiation is very nearly pro-

portional to the product $a \times (T^4 - t^4) \times h$, where
 a = area of steel or other material being heated
 T = absolute temperature of inside of furnace walls
 t = absolute temperature of surface of steel
 h = time (hours)

The total heat transmission is proportional to the sum of the products, one of which involves $(T - t)$, while the other involves $(T^4 - t^4)$. This difference of functions is decidedly inconvenient, and it is desirable from a practical standpoint, to eliminate it. This may be accomplished by factoring $T^4 - t^4 = (T - t)(T^3 + T^2t + Tt^2 + t^3) = k''(T - t)$. The factor k'' is now a variable, depending upon the value of T and t , but the formula for the entire heat transmission now contains only the factor $(T - t)$, instead of two different functions of the temperature difference.

Before definite values are assigned to the various

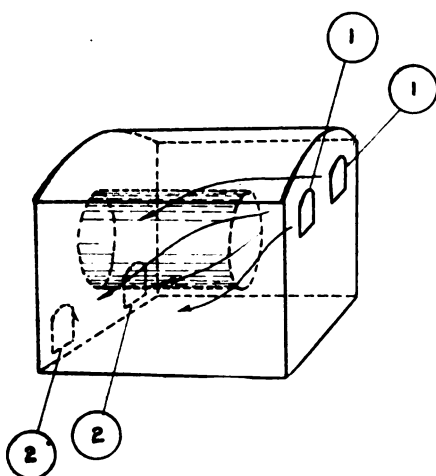


Fig. 2.

heat transmission constants, it is advisable to study in a general way how heat is transmitted to the steel, both by convection and by radiation. Fig. 2 represents a piece of steel lying in a furnace. Let the flame pass in through openings (1) (1) and out through openings (2) (2). Then several things will happen. If the flame is luminous, it transmits heat both to the furnace walls and to the steel by radiation, because flame temperatures are, almost without exception, considerably higher than furnace temperatures. The flame also transmits heat to the steel and to the furnace walls by convection, and finally, the furnace walls transmit heat to the steel by radiation. If the flame is not luminous, there is, of course no radiation from it. It will later on, appear that radiation plays an exceedingly important part in heat transmission in furnaces, so important that luminosity of the flame has a tremendous influence on the heating capacity of a furnace.

A given furnace with a luminous, radiant flame, will have a much greater heating capacity than if the combustion gases are clear and transparent.

It may be remarked in passing that luminosity is

caused by glowing carbon particles floating in the gas stream. It is always a sign of incomplete combustion at the place where luminosity occurs. To have both the latter and complete combustion, combustion must go on inside the furnace which means that free and uncombined oxygen must exist in the furnace. Sufficient space must then be allowed to insure complete combustion, before the glowing flame and the uncombined oxygen reach the steel, otherwise excessive scaling will result. This latter feature is frequently overlooked by inexperienced furnace designers.

It will, therefore, pay to start with a comparatively simple method of calculation, and to gradually add more and more refinement. The reader can then quit, whenever he feels that the additional refinements are uncalled for, or when the mathematics get beyond him.

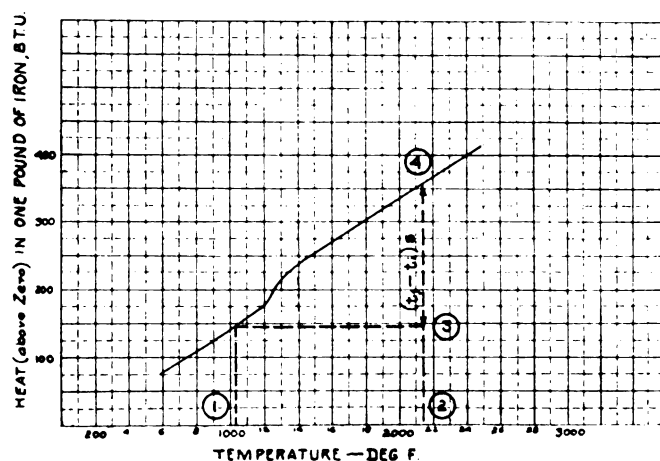


Fig. 3.

Let W = weight of steel to be heated, in pounds

a = area of steel exposed to heat, in sq. ft.

T^m = mean temperature difference between gas (or flame) and steel

t^i = initial temperature of steel deg. F.

t^f = final temperature of steel deg. F.

k = coefficient of heat transmission in Btu / sq. ft. deg. F. and hour.

s = specific heat of steel

k^a = an area coefficient

h = time (hours) in which the steel is to be heated from initial temperature to final temperature.

then the following holds

$$W \times (t^f - t^i) \times s = k \times k^a \times a \times T^m \times h \quad (1)$$

The lefthand member of the equation is the increase of heat contents of the steel, while the right hand member states how the heat gets into the steel through its surface. Although equation (1) is very crude, it is very useful, provided that the coefficient k^a and k , and the temperature difference T^m are selected with care.

Quite a number of factors of importance in furnace work are explained by it. Let us write the equation in the shape

$$\frac{W}{a} = \frac{k \times k^a \times T^m}{t^f - t^i} \times h$$

We see that, everything else being equal, the time required for heating an ingot or a billet is proportional to W/a . To further illustrate this relation consider a line of ingots the length of each of which is three diameters. Then

$$\frac{W}{a} = \frac{\frac{\pi}{4} d^2 \times 3d \times .29}{2 \times \frac{\pi}{4} d^2 + 3\pi d^2} = \frac{\frac{.29 \times 3}{4}}{\frac{1}{2} + 3} \times d = .0625 d''$$

The time required to heat steel is, therefore, directly proportional to the linear dimensions of the ingot or billet, everything else being equal. If, for instance, a 10-inch diameter ingot can be heated in $\frac{1}{4}$ hour, then a 20-inch diameter ingot can be heated in $\frac{1}{2}$ hours, and a 30-inch diameter ingot can be

the temperature range $t^f - t^i$ through which the steel is to be heated. Then the distance (3) (4) equals the heat increase $(t^f - t^i) \times s$. Curve 3 is based on Oberhoffer's experiments. Tests made in the mechanical engineering laboratory of the Carnegie Institute, gave practically coincident results.

Values for the heat transmission coefficient k must, as will be clear from previous explanations, vary a great deal. This variation is the principal drawback to equation (1), because good results can be obtained only by the use of correct coefficients. Incidentally, it may be remarked that any formula which has had the complication of physical facts extracted or eliminated by the use of "coefficients of experience" suffers from the probability of incorrect use of coefficients. With this word of caution, the following chart for heat transmission coefficients is offered, (see Fig. 4).

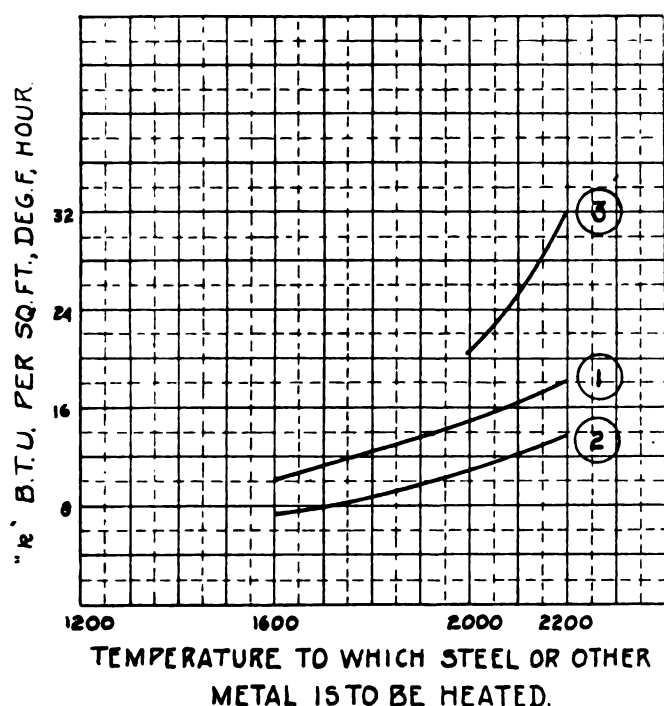


Fig. 4.

heated in $2\frac{1}{4}$ hours, again with the emphasis on everything else being equal. The latter requirement is, however, seldom fulfilled in practice. In the case of small billets or ingots the mass and interior brick surface of the furnace are usually small compared to the dimensions of the ingot. The large ingot pulls down the furnace temperature much more than the small ingot. For that reason the simple linear relation $W/a = \text{constant} \times h$ does not hold, and the time required for heating rises faster than the linear dimensions.

For practical use of equation (1), we must have numerical values for s , k , k^a , and k^m . The first of these, s , the specific heat, is best taken from a total heat-temperature curve. Fig. 3 shows such a curve for plain carbon steel. (Compiled from Marks, page 296).

In that illustration let the distance (1) (2) equal

Curve No. 1 is to be used where the brick heating surface and the mass of the brick are large compared to the surface and the mass of the steel to be heated. Curve No. 2 holds when the reverse is the case. Both curves are based on an ideal constant wall temperature of 100 F. above that temperature to which the steel is to be heated. The curves are intended to take care of the tremendous increase of heat radiation at high temperatures. Curves (1) and (2) are for furnaces of the non-continuous type, that is to say for that type in which the hot material is withdrawn from the same door through which it was charged. Curve (3) holds for well designed continuous heating furnaces in which the flame and furnace temperature is considerably higher than the final temperature of the steel. For reasons which will appear later on, this curve holds for continuous furnaces with a luminous flame only. Examples for the use of the coefficient will be given later.

The next coefficient to be investigated is k^a , the area coefficient. It equals the ratio of

$$k^a = \frac{\text{surface exposed to heat}}{\text{total surface of steel}}$$

From Fig. 5 which represents a part of a continuous furnace heating rounds, it is clear that the bottom halves of the rounds are not exposed to the heat. The coefficient k will, therefore, be $\frac{1}{2}$ at best, if the end surfaces are neglected. But the depressions are not as well heated as the tops, hence k^a in this case may be taken as $\frac{1}{4}$. Similar reasoning can be employed in every case.

The last variable to be discussed in connection with equation (1) is T^m . Fig. 6 illustrates the temperatures of the furnace walls and of the steel in an intermittent furnace, plotted against time. The word intermittent is here used in contradistinction to the word continuous. It means a furnace such as a forge furnace, or an annealing furnace in which the piece is put in and taken out through the same door. In the

determination of the mean temperature difference the difficulty arises that the cold steel reacts on the furnace temperature. The reaction is scarcely noticeable if the ingot is small compared to the furnace (upper, solid line). It is very noticeable, if the ingot is large compared to the furnace dimensions (lower, dotted line). For the purpose of the present simple calculations the initial drop of temperature is neglected, but its effect is, in a measure, taken care of by a lowering of the coefficient of heat transmission, see Fig. 4. The steel surface temperature will be a curve such as indicated in Fig. 6, rising quickly at first, and slowly towards the end. In view of the crudeness of the whole matter it is permissible to choose $T^m = 1/3 (T^f - T^e)$, where T^f furnace temperature and T^e the temperature of entering steel, or other material to be heated.

In continuous furnaces the mean temperature difference is the mean between the at cold end and at hot end.

To illustrate the method of calculation, let us compute the time required to heat a 20-inch ingot from 100° F. to 2,200° F. From the curve of Fig. 4 we find the heat content at 2,200° to be 370 Btu, while at 100°

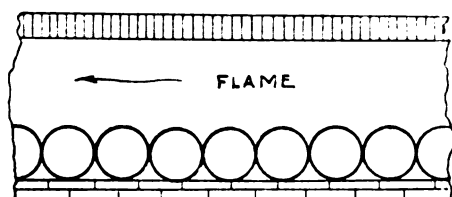


Fig. 5.

it is 12 Btu. Consequently 358 Btu are to be put into each pound of steel. Consider unit length of the ingot, for instance 1 foot. Then weight to be heated equals $\frac{\pi}{4} 20^2 \times 12 \times .29 = 1,100$ pounds. Hence heat input per foot of length is $1,100 \times 358 = 395,000$ Btu. Let the ingot lie on or near the hearth, then about 80 per cent of the circumference is effective for heat transmission. Hence $k^a = .8$. It is advisable to neglect the end surface, because, while heat is transmitted out through it into the steel, heat is also transmitted out of the opposite end into the open. Then heating surface per foot of length equals $.8 \times \pi \times \frac{20}{12} \times 1 = 4.2$ sq. ft. From the curve of heat transmission coefficients we find k to range between 14 and 18, depending upon whether the furnace is small or large for the ingot. Let the furnace be small, then $k = 14$. The mean temperature difference is $1/3 (2,300 - 100) = 730$. Then

$$\text{hours for heating} = \frac{395,000}{4.2 \times 14 \times 730} = 9.2 \text{ hours}$$

If the furnace be large, the time is $14/18 \times 9.2 = 7$ hours and if the ingot be supported on blocks, resting

a good distance above the hearth the whole circumference is available for heating, and the time is reduced to $.8 \times 7$ which approximately equals 5 hours.

As an example for the use of curve No. 3, let us

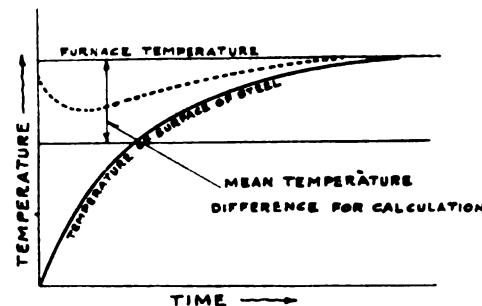


Fig. 6.

figure the time in which 2×2 billets are heated to 2,200 degrees in a continuous furnace. As before the heat input per pound is 358 Btu. These billets usually lie close together, and are very long (30 ft.) so that only the top surface is available for heating. Let us consider a billet 1 foot long. Its weight is $2 \times 2 \times 12 \times .29$ or 14 pounds. Its rise in heat equals 5,000 Btu. Its heating surface is $1/6$ sq. ft. The mean temperature difference is found from Fig. 7. It is roughly $\frac{1}{2} [(1)(2) + (3)(4)]$. Let the flame temperature be 3,000 F., then $(1)(2) 3,000 - 2,200 = 800$. Let the final gas temperature be selected to be 1,200 F., then the temperature difference at the cold end is $1,200 - 100$, or 1,100, which makes the average temperature difference equal to 850 F.; the coefficient from curve 3 of Fig. 4) is 32 which makes the time equal to $\frac{5,000}{1/6 \times 32 \times 950} = 1.0$ hours, approximately.

Although at high temperatures heat is mainly distributed by radiation, convection plays a very important part, as may be judged from the following.

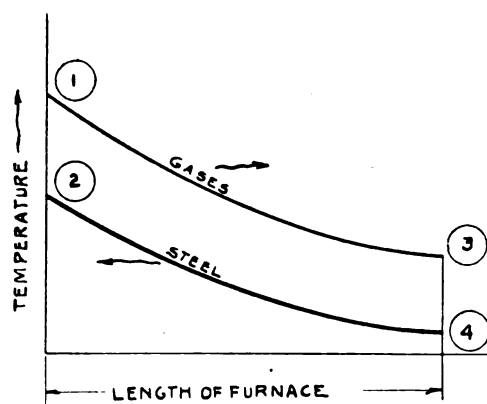


Fig. 7.

While the whole interior of the furnace radiates heat to the steel, that heat which is thus given up by the walls must be replenished, either by radiation from the flame, or by convection from the flame gases. The

(Continued on Page 80)

Review of Iron and Steel Literature for 1918

A Classified List of the More Important Books, Serials and Trade Publications During the Year; With a Few of Earlier Date, Not Previously Announced.

By E. H. McCLELLAND,
Technology Librarian, Carnegie Library of Pittsburgh.

Though 1918 was an important year in the steel industry, the production of literature on iron and steel was attended by considerable difficulty. Government work necessitated a certain amount of secrecy in the industry, thereby increasing the difficulty of presenting up-to-date developments, either in books or in the current journals. The stress of other essential duties retarded the rather onerous work of compiling the annuals which are looked to for the statistics of the industry; with the result that these appeared tardily or not at all.

The following list represents a selection from the literature of 1918, with a few works of earlier date only recently announced or received in this country.

Iron and Steel.

Backert, A. O.—A B C of iron and steel; with a directory of the iron and steel works and their products of the United States and Canada. Ed. 2. 344 pp. 1917. Penton Publishing Company, Cleveland.

Practically the same as first edition. Directory of steel works has been revised.

Blair, Andrew Alexander—The chemical analysis of iron. Ed. 8. 318 pp. 1918. J. B. Lippincott Company, Philadelphia.

Largely rewritten. Ed. 7 appeared in 1908. The standard guide to analysis of iron, steel, fluxes, refractory materials, etc.

Bonini, C. F.—I processi termoelettrici della siderurgia moderna; forni elettrici. 1914. U. Hoepli, Milan.

"An excellent treatise conceived on a very comprehensive basis. * * * The author has packed a mass of useful information into his book, and the student has plenty of material placed at his disposal to make himself thoroughly familiar with electric furnaces and their working."—*"Iron and Coal Trades Review,"* February 1, 1918, p. 124.

Bradlee, Francis B. C.—The Salem iron factory. Essex Institute, Salem, Mass.

A pamphlet dealing with early iron manufacturing in Essex county, Mass.

Brearley, Arthur W. and Brearley, H.—Ingots and ingot moulds. 281 pp. (1918). Longmans, Green & Co., New York.

Deals with crystalline structure, shrinkage and contraction cavities, casting temperatures, ingot molds, methods of casting, sound ingots, blow holes, segregation, slag occlusions, and influence of ingot defects on forged steel.

Bullens, Denison K.—Steel and its heat treatment. Ed. 2. 483 pp. 1918. John Wiley & Sons, New York. Published 1917.

Butler, Joseph G.—Fifty years of iron and steel. 114 pp. 1918. Penton Publishing Company, Cleveland.

Reprint of address at thirteenth general meeting of American Iron and Steel Institute, Cincinnati, October 26, 1917.

Carnegie Library of Pittsburgh—Case-hardening. 10 pp. 1918.

A list of references to material in books, journals and United States patent literature.

Field, Alexander L. & Royster, P. H.—Slag viscosity tables for blast-furnace work. 38 pp. 1918. (United States Bureau of Mines. Technical paper 187.)

Goffi, Carlo—Tecnica moderna degli acciai. U. Hoepli, Milan.

"The author * * * combines a practical knowledge with a full theoretical mastery of his subject, and he has also the gift of making the subject clear to others, the result is an excellent treatise in a compact form."—*Iron and Coal Trades Review,* December 21, 1917, p. 700.

Jacquet, Alexis—Aciers, fers, fontes. 197 pp. 1918. Dunod & Pinat, Paris.

Constitution, tests, heat treatment, and cementation. Considers iron, ordinary steels, special steels and tool steels; also the selection of steels and the mechanical treatment of steel.

Jernberg, John—Forging. 131 pp. 1918. American Technical Society, Chicago.

Concise work, especially for students. Describes tools and methods of hand forging, and shop practice in hardening, annealing and tempering of steel.

Johnson, J. E.—Principles, operation and products of the blast furnace. 551 pp. 1918. McGraw-Hill Book Company, New York.

Valuable work, combining theory and practice. Gives considerable attention to commercial features. Forms an adequate supplement to author's "Blast-furnace Construction in America." 1917.

Levi-Malvano, Mario—Tempera e cementazione dell'acciaio. 261 pp. 1917. U. Hoepli, Milan.

Theory and practice.

Lindeman, Einar, & Bolton, L. L. comp.—Iron ore occurrences in Canada; introductory by A. H. A. Robinson. 2 v. in 3. 1917.

V. 1. Descriptions of principal iron ore mines

V. 2. Descriptions of iron ore occurrences.

(V. 3.) Maps.

"Bibliography," V. 1, p. 22.

Issued by the Mines branch of the Department of Mines, of Canada.

Manlove, George H. & Vickers, Charles—Scrap metals, by G. H. Manlove (and) old metals by C. Vickers. 278 pp. (1918.) Penton Publishing Company, Cleveland.

These two works, combined in a single volume, constitute the first book published on the subject. Contains much valuable information for the buyer, the seller, and the consumer of scrap and waste metals.

Newton, E.—Manganiferous iron ores of the Cuyuna district, Minnesota. 126 pp. 1918. University of Minnesota. Minnesota School of Mines. Experiment Station. Bulletin 5.

Penton Publishing Company—Complete list of base prices, differentials and extras on iron, steel and non-ferrous products, fixed under government supervision. 42 pp. 1918. Penton Publishing Company, Cleveland.

Reiser, Fridolin—Hardening and tempering of steel in theory and practice. English Ed. 2. 139 pp. 1918. Translated from German Ed. 3. Scott, Greenwood & Son, London.

Rodenhauser, W. & Schoenawa, I.—Electric furnaces in the iron and steel industry. Ed. 2. 429 pp. 1917. John Wiley & Sons, New York.

"Useful to the furnace builder, the student, or anybody who is interested in electric furnaces for the production of iron and steel. * * * Rewritten from the first edition to keep abreast of the remarkable expansion in electric furnace practice."—*Foundry*, March, 1918, p. 138.

Sauveur, Alb.—Metallography and heat treatment of iron and steel. Ed. 2. 486 pp. 1918. Sauveur & Boylston, Cambridge, Mass.

This has just been announced with imprint date 1918. It is evidently a reprint of Ed. 2, 1916.

Steel Mill Directory of the United States and Canada—Containing a list of all the blast furnaces, steel mills and steel foundries, with the names of their executives and operating officials. 221 pp. 1918. THE BLAST FURNACE AND STEEL PLANT, Pittsburgh.

Published annually for the exclusive use of advertisers in THE BLAST FURNACE AND STEEL PLANT. Not for sale or general distribution.

White, G. A.—A metallurgical study of the steel base as related to galvanizing; being volume one of a series on the manufacture of sheet steel. 58 pp. 1918. Matthews-Northrup Works, Buffalo.

Valuable study of physical, chemical and metallographic properties of the various types of commercial steel sheets.

Whittier, William Harrison—An investigation of the iron ore resources of the Northwest. 128 pp. 1917. Seattle. (University of Washington—Bureau of Industrial Research. Bulletin No. 2.)

Considers ore deposits of Washington, Oregon, California, British Columbia and Alaska, and discusses history of the iron industry, fuels and fluxes, markets, production costs and ore analyses.

Refractories.

American Gas Institute—Bibliography of articles on refractory materials; compiled by the refractory materials committee of the American Gas Institute and the gas refractories committee of the refractories manufacturers' association, with the assistance of the Bureau of Standards. American Gas Institute. New York. 1918.

American Gas Institute—Report of committee on refractory materials. 1918. American Gas Institute, New York.

Faraday Society—Refractory materials. The Society, London. 1917.

A reprint of the Society's Transactions, June, 1917, pp. 86-273. Technical papers and discussions. Of interest to steel men.

Searle, Alfred Broadhead—Refractory materials; their manufacture and uses. 1917. Griffin.

Treatise on occurrence and properties of raw materials, and manufacture, selection and application of refractory products. Very few books are available on the subject, and this work is a valuable one although it does not fully represent the American industry, and is not altogether up-to-date, as it was completed in 1914. Contains useful information for steel men on selection and application of refractories.

Statistics.

Several valuable annual publications have been delayed. The Annual Statistical Report of the American Iron and Steel Institute has not appeared; the "Mineral resources" of the United States Geological Survey is not available in complete form later than 1915, while the advance section on iron and steel for 1916 was not published until 1918. The Mineral Industry during 1917 was later than usual, being issued almost at the end of 1918. Of the statistical reports issued during the year the following are the most important:

Burchard, Ernest F.—Iron ore, pig iron and steel in 1916. Published February 13, 1918.

An advance pamphlet constituting pages 507-564 of the United States Geological Survey's "Mineral resources."

Iron, Steel and Allied Trades Federation—Statistical report for 1917; statistics of the iron and steel industries, including statistics of coal, coke and iron ore of the British Empire and foreign countries. 59 pp. 1918.

The Mineral Industry During 1917—McGraw-Hill Publishing Company, New York.

The most comprehensive annual reviewing the mining and metallurgical industries in America and abroad. It is by no means confined to statistics, but contains also much general technical information. Contains 53 pages on iron and steel by E. F. Cone.

Metal Statistics—427 pp. Ed. 11. 1918. American Metal Market Company, New York.

Detailed information regarding production and prices of ferrous and non-ferrous metals.

The British government has issued a pamphlet, mainly statistical, dealing with the iron and steel industry of Japan.

Periodicals.

In the spring of 1918, "The Steel and Metal Digest" (Pittsburgh) enlarged its field and one of its valuable features at present is a section devoted to abstracts of current literature on iron and steel. It is the only monthly journal giving this information. Its more timely appearance gives it a certain advantage over the "Journal of the Iron and Steel Institute" (London) which contains a much more comprehensive series of abstracts, but which appears only semi-annually. Volume 97 of this latter "Journal," covering the first half of 1918 was recently issued. This volume, of nearly 600 pages, contains the report of the proceedings of the annual meeting held in London in May, 1918, with the papers presented to the Institute on that occasion, and the discussions and correspondence thereon. A report from Technical Committee No. 2 for blast-furnace practice is also included, together with the discussions and communications thereon. The second section of the volume consists, as usual, of the record of progress of the home and foreign iron and steel industries. This year, however, considerations of

space have necessitated the omission of the sections dealing with coal mining, liquid fuel, chemical analysis, and bibliography of recently-published literature.

The Proceedings of the Association of Iron and Steel Electrical Engineers forms an annual volume of about 800 pages, and the volumes for 1916 and 1917 constitute the best single source of information on the important subject of electric drive in the steel industry.

A general topical index to the first five volumes of THE BLAST FURNACE AND STEEL PLANT, was published in January, 1918.

A committee of the American Library Association has been successful in securing the more important German journals for a number of the larger libraries. *Stahl und Eisen* has been received for the greater part of 1917-18, and is appearing regularly, though somewhat reduced in size. *Ferrum* is reported discontinued.

The following are new journals in the field of ferrous metallurgy:

Iron and Steel of Canada—(Monthly. Toronto). First published early in 1917.

Journal of American Steel Treating Society—(Monthly. Chicago.) First issued in October, 1918.

Devoted to literature "bearing upon processes, instruments, equipment, apparatus, etc., employed in practical research work connected with the art, collection, publication and dissemination of technical and practical knowledge for the improvement of conditions in connection therewith." Constitution of the Society.

Proceedings of the Steel Treating Research Society—(Monthly. Detroit.) First issued in August, 1917.

Purpose is to bring into closer connection the technical man and the practical worker in this field, and to create a permanent record of the experience of both.

Miscellaneous—Books of Probable Interest to Steel Men.

Andes, Louis Edgar—Iron corrosion; anti-fouling and anti-corrosive paints. English. Ed. 2. 296 pp. 1918. Scott, Greenwood & Son, London.

Berry, Gordon L. & Bradshaw, T. P.—Eye hazards in industrial occupations. 150 pp. 1918. National Committee for the Prevention of Blindness.

"Undoubtedly the most complete compilation of material relating solely to the prevention of eye accidents that has been published in this country."—*Iron Age*, February 7, 1918. p. 425.

Christopher, J. E. & Byrom, T. H.—Modern coking practice, including the analysis of materials and products. 124 pp. 1917. Crosby, Lockwood & Son, London.

Fay, Albert H.—Coke-oven accidents in the United States during the calendar year 1917. 19 pp. 1918. (United States Bureau of Mines. Technical Paper 206.)

Ferry, Ervin Sidney, and others—Practical pyrometry; the theory, calibration and use of instruments for the measurement of high temperatures. 147 pp. 1917. John Wiley & Sons, New York.

Contains information of value to metallurgists.

Gebhardt, George Frederick—Steam power plant engineering. Ed. 5. 1057 pp. 1917. John Wiley & Sons, New York.

The most comprehensive work on the subject.

Giua, Michele & Giua-Lollini, Clara—Combinazioni

chimiche fra metalli. 446 pp. 1917. U. Hoepli, Milan.

An attempt to classify the results obtained through recent advances in metallurgy and metallography. Considers thermal analysis, physical properties and compounds of metals.

Harrison Safety Boiler Works, Philadelphia—Finding and stopping waste in modern boiler rooms, by George H. Gibson and P. S. Lyon. 276 pp. 1918. The Company, Philadelphia.

Herington, C. F.—Powdered coal as a fuel. 211 pp. 1918. D. Van Nostrand Company, New York.

"Bibliography," pp. 191-202, reprinted from *Journal of the American Society of Mechanical Engineers*. 1916.

The only American work on the subject. Deals with proper coals, pulverizing, and burning, and considers special applications, including a chapter on powdered coal in metallurgical furnaces.

Lockhart, Luther Bynum—American lubricants, from the standpoint of the consumer. 236 pp. 1918. Chemical Publishing Company, Easton, Pa.

"References" at the end of a few chapters.

An important addition to the scanty literature of the subject. Outlines manufacturing methods; considers lubrication of various kinds of machinery, and the essential properties of lubricants; discusses chemical and physical testing of oils and greases; and gives many specifications.

Machinery's encyclopedia; a work of reference covering practical mathematics and mechanics, machine design, machine construction and operation, electrical, gas, hydraulic and steam power machinery, metallurgy and kindred subjects in the engineering field; comp. and ed. by Erik Oberg and F. D. Jones (and others). 7 v. 1917. Industrial Press.

V. 7 is an index and guide to systematic reading.

The only modern American work of its kind. Affords a comprehensive treatment of mechanical engineering and machine-shop practice, and deals less exhaustively with metallurgy and applied electricity. Treatment is concise and practical and usually quite extensive. Topics are arranged alphabetically and detailed reference is facilitated by a comprehensive index (V. 7). The illustrations are of special merit.

Nickles, John M.—Bibliography of North American geology for 1917. (United States Geological Survey. Bulletin 684.)

References to the literature of the year in federal and state geological surveys, and in magazines. Includes material on mining and metallurgy.

Owen, Hubley Raborg—Treatment of emergencies. 350 pp. 1917. W. B. Saunders Company, Philadelphia.

Peele, Robert—Mining engineers' handbook. 2375 pp. 1918. John Wiley & Sons, New York.

The first comprehensive work in this field. In content and arrangement compares very favorably with the "pocket-books" in other branches of engineering. Deals only briefly with iron mining, but will be of interest to the steel industry as an exhaustive reference work on all branches of mining.

Poole, Herman—Calorific power of fuels. Ed. 3, rewritten by Robert Thurston Kent. 267 pp. 1918. John Wiley & Sons, New York.

"Has been practically rewritten to incorporate the latest researches not only on coal, but on fuels which to a great extent have replaced or supplemented coal."—*Railway Age*, March 1, 1918, p. 440.

Warnes, Arthur R.—Coal tar distillation and working up of tar products. Ed. 2, revised and enlarged. 302 pp. 1918. D. Van Nostrand Company, New York.

A British book primarily for the chemist, and not of direct interest to the steel worker. Mentions coal firing and coke testing briefly. First edition appeared in 1913.

Electric Furnaces for Steel Foundry Work

Basic Steel Recommended on Account of the Possibility of Working to Closer Phosphorus and Sulphur Limits—Advocates Furnace Shell of Large Diameter With Shallow Bath.

By W. E. MOORE.

Until about five years ago, the electric furnace in the steel foundry was practically unheard of. It was generally understood that the product of the electric furnace while of the highest quality, was so costly to make that it might be considered commercially practicable only for the production of the best tool steel, or the highest grades of alloy steel.

In the last two years, a great light has broken over the electric furnace situation for the steel foundrymen. Today the foundrymen are beginning to consider most favorably the electric furnace for steel foundry work, as by that process both small and moderate sized castings of intricate character can be made wherever suitable electric power is available, better, I believe, than by any other known process. This statement will be surprising to many, but it is borne out by the records from a number of operating plants. Steel foundry practice only follows out the general rule that whatever can be made better by an improved process will in the end be manufactured cheaper.

Primarily, electric steel became popular for its superior physical properties. While such steel can be made with a more satisfactory chemical analysis, using the same grade of raw materials than by other processes, experience has abundantly demonstrated that when made to the same chemical analysis, it will average about 15 per cent greater tensile strength or ductility, depending upon its heat treatment, and is more resistant to shock and better able to receive heat treatment. The reason for this is that the steel, being made in a closed furnace and in a reducing atmosphere away from the contaminating influence of combustion gases, is more solid, freer from gases and less prone to intrusions. Being absolutely dead when properly made, and averaging lower in sulphur, electric steel is less liable to show shrinkage cracks between ribs and being more fluid it is not liable to piping or blow holes.

Since electric steel can be made quite hot, a large proportion of the heat can be shanked off with less loss from skulls in the ladles. With acid electric steel it is customary to use lip-pour ladles, but when basic steel is being made, bottom tap or teapot spout ladles are generally preferred so as to prevent contact of the basic slags with the silica of the molds.

Comparative Cost Data.

The following figures show present day comparative operating costs for liquid steel in the ladle:

Paper read before American Foundrymen's convention.

Average Charge for Two Tons of Converter Steel Divided Into Four Cupola Charges.

912 low phosphorus pig iron.....	\$ 55.00	\$22.60
912 bessemer pig iron	34.40	14.00
1816 steel scrap	30.00	24.30
300 silicon and spiegel	120.00	19.33
333 coke	10.00	1.49

Total cost of charge for two net tons of steel.....	\$ 81.72
For one net ton of steel.....	45.86
Additions per ton of steel:	
10 pounds 80 per cent ferromanganese at 15c.....	\$ 1.50
6 pounds 50 per cent ferrosilicon at 8c.....	.48
1 pound aluminum	.33
Power for blower motor	1.25

Total cost materials and power per net ton of steel	\$ 49.42
Average cost of cupola and converter linings.....	1.20
Labor cost	3.00

Cost of converter steel per net ton.....\$ 53.62

Average Charge for Three-Ton Acid Lined, High Power, Rapid Type, Polyphase Electric Foundry Furnace.

Charge	Price per net ton	Cost for 3 tons	Cost per net ton
6200 machine shop turnings.....	\$ 19.00	\$58.10	\$19.30
100 mill scale	5.00	.25	.09
60 electrodes	180.00	5.40	1.80
1650 kilowatt hour (550 per ton) electric power at 1c per unit.....		16.50	5.50
20 eighty per cent ferro-manganese	300.00	3.00	1.00
15 fifty per cent ferrosilicon.....	160.00	1.20	.40
1½ pound aluminum	660.00	.50	.17

Cost of materials and labor for 3 tons of liquid steel....	\$ 85.04
Cost of materials and labor per ton of liquid steel....	28.35
Average cost of linings and roofs.....	.50
Labor cost on furnace	2.00

Cost per net ton of electric steel in the ladle.....\$ 30.85

Acid Open-Hearth Practice.

The acid open-hearth furnace is still frequently used, generally with oil fuel and mostly in foundries making the heavier classes of steel casting. With the acid open-hearth furnace the standard price must be paid for low phosphorus heavy melting scrap. The fuel oil consumption for such open-hearth furnaces in foundries usually runs from 45 to 90 gallons, costing at the present time from \$3.75 to \$7.50 per ton of liquid steel. In the largest of the steel foundries, it is true, producer gas is frequently used at less fuel cost. However, the contaminating effect of the sulphur content of the coal and the complications and expense of the producer plant as a rule deters the ordinary steel foundry from using coal as open-hearth fuel.

The great drawback of the open-hearth furnace is its well known inability to furnish steel sufficiently hot to satisfactorily make medium and small castings without undue costs for refractories and largely increased fuel consumption. The inconveniently large

heats of the open-hearth furnace, 15 to 40 tons, count heavily against it in small casting work.

As to the most suitable type of electric furnace for installation in the ordinary steel foundry, the writer believes that basic steel will be demanded by many producers, who will then lower their limits of sulphur and phosphorus to a level not practicable to reach with the acid furnace using commercial grades of scrap. At present the call is for acid-lined furnaces, as present specifications are liberal as to sulphur and phosphorus content and high grade shrapnel and other munition scrap is available in large quantities. The acid furnace is simpler, cheaper and faster to operate.

It is strongly recommended that a furnace be purchased so designed and constructed that it is adaptable to basic operation. This means that the furnace shell must be of large diameter and the bath must be of large area and shallow. The furnace should not, in our judgment, be of the long arc type nor of the small diameter shell deep bath type, if the best work is contemplated. Indeed even for acid melting there is a noticeable difference in the quality of the steel obtained from the large diameter, shallow bath furnaces compared with that made in the deep bath type of furnace, for with the latter it is not feasible to obtain the same mechanical reactions from the additions put in to refine the steel as when the bath is of the shallower type. Nor is it possible to so thoroughly deoxidize the metal by maintaining the reducing atmosphere in the furnace.

For foundry work it is especially important to have the furnace constructed with all possible operating conveniences and facilities, so that one heat may follow another with the utmost rapidity and with a minimum loss of time for the necessary furnace adjustments. It is therefore important to look carefully to the facilities for making bottom and fettling the banks.

Maintenance Facilities.

All practicable facilities must be at hand for maintaining the spouts, maintaining and renewing the roofs and door liners and also for convenience in adjusting the electrodes in their clamps. Suitable apparatus for switching and adjusting the currents and voltages with which it is desirable to operate also should be provided. Practically all modern furnaces are now equipped with automatic regulators, which save a large amount of the attendant's time and do the work better than is possible with hand regulation. The very best facilities should be provided for handling the slag from the furnace and for tapping off the liquid steel. It is the opinion of the writer that the slag can best be handled by tilting down the charging door, that is tilting the furnace backward, so that the slag may be poured or raked off into a covered slag box, where its heat and presence do not interfere with and delay the operation of tapping the steel into the ladle.

It is strongly recommended that the furnace be

kept as free from parts of machinery located underneath the shell as possible, for there is nothing that disgusts the operator more than to have a heat of steel cut through the furnace bottom and "gum up" a lot of gears, shafts, motors, etc. It may be argued that a cut-through of the bottom is the result of careless operation, which it certainly is, but it must be remembered that the only safe rule is that whatever can happen surely will happen sooner or later.

From the power station standpoint, which also affects the cost of the power to the user, certain important considerations must be observed. The furnace should be of such size as will enable it to be maintained in practically constant operation, as all power is now sold on a load factor basis, and the more nearly continuously a furnace can be operated, the smaller that proportion of the bill for readiness to serve as compared with the energy charge will become, which means that the average cost of power per unit will be less. The furnace efficiency also will be higher, which makes the saving all the more important.

It is likewise important that the furnace should be operated with the shortest possible periods between heats, for during such periods, the user loses a portion of his demand time, which would increase the readiness to serve charge. Also the furnace lining is cooling down quite rapidly and the electrodes are oxidizing away more rapidly than when melting the charge.

In some cases off peak power is available at prices which usually do not embody more than a portion, if any, of the readiness to serve charge. In such cases it is frequently practicable to operate the furnace more cheaply during the off peak periods, such as at night, on holidays, Saturday afternoons and Sundays.

It is quite important that the furnace should operate at the highest practicable power factor which can be obtained without undue disturbance of the power company's load, for by so doing the electrode, transformer, line and generator losses are maintained at a minimum. Engineering skill of a high order is required to forecast and select the best type of equipment, under the many varied power supply conditions which obtain in different localities.

Unbalanced Loads Are Shunned.

Power companies without exception dislike to receive a single phase or unbalanced load. They either refuse to handle such a load at all or penalize the user by **charging a higher rate**. It is, therefore, essential for furnaces above the smallest sizes, say $\frac{3}{8}$ tons capacity or less, to be arranged to receive a balanced polyphase power supply.

It is often asked when the electric furnace field will become saturated and electric furnaces no longer desirable purchases. It is believed the natural growth of the high grade, medium and small size steel casting business will continue for years to come and demand the installation of a large number of electric furnaces.

German Foreign Trade Extension Measures

Private Associations for Promoting Foreign Trade—German Exhibitions—Government Trade Activities—Need of Central Organization—Purposes of Suggested "Auslandamt."

By TRADE COMMISSIONER NORMAN L. ANDERSON.

IN the German economic press, the difficulty connected with the re-establishment of German foreign trade after the war is often pointed out. On account of the great changes in internal economic strength and the relations of the various countries, an entirely new condition in world trade has arisen. Some countries are suffering from great debts; others have only increased in strength financially. Each country is endeavoring as much as possible to be independent economically and particularly in regard to their industrial relations abroad. In order to accomplish this, in each country there are being formed new steel mills, factories, shipyards, shipping companies, etc., which at the signing of peace will be able to threaten seriously any German competition. Germany, having been cut off from world trade for the last four years will be obliged to concentrate all its strength so that it will be able to pick up its old commercial relations and establish new ones.

Even before the war measures of this kind were taken in Germany, and there was organized a whole series of concerns with the object of increasing Germany's foreign trade. During the war the number of these firms has greatly increased.

Private Associations for Promoting Foreign Trade.

The measures of the Germans to widen their foreign trade have been mainly by the formation of private concerns, of which may be mentioned the Deutsch-Weltwirtschaftliche Gesellschaft, Verband des Deutschen Einfuhrhandels, and Handels-Vertrags-Verein. In addition, there are the Auslands-Museum in Stuttgart, Glaubigerschutz-Verband fur Forderungen in Feindesland, and about 40 similar associations.

There are even more associations whose fields are limited within certain geographical boundaries. For example, the Deutsch-Osterreich-Ungarische Wirtschaftverband and the Deutsch-Russische Verein are to increase commercial relations with those peoples. Many groups of those so-called "two-government" associations have already united, as, for example, the Deutsch-Argentinische Zentralverband and the Brasilianische Handelsverband have consolidated into the Verband fuer Sued und Mittel Amerika. This was done in order to cut out duplication of effort.

Besides these there exist in Germany a whole series of associations which are endeavoring to in-

From report made by author for Bureau of Foreign and Domestic Commerce.

crease the interests of the German colonies. In addition to the Verein Deutsch Export-Fabrikanten and the Export-Verein in Konigreich Sachsen, there are about a dozen of these organizations.

German Exhibitions Abroad—Shipping Information—Commercial Papers.

Several branches of the German industries, in addition to all that have taken other steps, as, for example, the Vereinigung fur die Zollfragen der Papierverarbeitenden Industrie and Gesellschaft fur Deutsche Kunst im Auslande—have arranged abroad exhibitions of German goods to acquaint the foreign public with the results of German arts and to develop a large market for German goods.

Only very lately have they begun to understand in Germany the importance of giving information, and only recently have the Germans formed such organizations as Transoceans Gesellschaft mit Beschränkter Haftung and Seediens, whose object will be to compete with the English information gathered through Lloyds. These new German organizations intend to commence their activities after peace has been signed.

The Germans are also endeavoring to coöperate in the interest of increasing their foreign trade by publishing papers and journals. There are now in Germany about 60 private papers and 10 official ones of this class, besides which many of the associations mentioned issue special bulletins for their own members and for the press. In this last field of endeavor the Germans have been particularly active.

Government Trade Activities.

Besides all these activities, which may be considered as founded on private initiative, various government organs are working for the increase of German foreign trade.

In a line with the boards of trade as semi-official organs, there exist in addition Die Standige Ausstellungskommission fur die Deutsche Industrie and Zentralauskunftsstelle. The Germans expect a great deal from this last company, which in their opinion can greatly assist Germans returning from enemy-alien countries, particularly in organizing and regulating the stream of German farmer emigrants from Russia.

It is pointed out that one of the most important results to be obtained is the increase of the German spirit among German subjects residing abroad, since

this is a great advantage, even in increasing German foreign trade. For this there exists, besides the Verein Deutscher Staatsangehöriges im Auslande, the Verein für das Deutschtum im Auslande. These organizations, in the opinion of many Germans, should be united into one national association. Several of these associations have already consolidated with different objects, as the Vereinigung zur Errichtung Deutscher Technischer Schulen, in China, the Buchhändler-Komitee zur Verbreitung Deutscher Lehrmittel, in China, and many others. These associations total about 30.

Further, for the trade and industry of Germany, its associations of an educational character are considered of great importance. These have in view the study of foreign lands. Among them may be mentioned the Gesellschaft zur Studium Russlands. In connection with this it is important to point out the Zentral Verein für Handels-Geographie and the Förderung Deutscher Interessen im Auslande, the Koppel-Stift zur Förderung der Geistigen Beziehungen Deutschlands zum Auslande, and about 40 analogous associations, some of which have been founded by Germans abroad.

On a par with these educational associations there exists also a whole series of institutes, such as the Deutsch-Sudamerikanische Institut, that have for their object the systematic spread of "German Kultur" abroad. In particular the Institut für Seeverkehr und Weltwirtschaft, founded by Prof. Harms in Kiel, must be borne in mind, since in the very short period of its existence it has succeeded in attaining widespread activity.

Need of Central Organization.

Meanwhile it is frequently stated that many of these measures lose strength, owing to the lack of a centralized system. In this connection the Germans point out the difficult position of their country, owing to its almost complete severance from world trade. In the years during which Germans have been unable to supply foreign markets these markets have established their own industries; and the German dye industry, shipping industry, etc., will be compelled after the war to meet very sharp competition.

It is further added that owing to the great losses in Germany of both men and material the growth of its trade and commerce after the war will be much retarded. On this account it is pointed out that in the efforts to increase German foreign trade duplication and dissipation of strength cannot be permitted, and it should therefore be the aim to form the most centralized and systematized organization for this object. In the opinion of many Germans, first of all it would be better to consolidate into one association all the so-called "Handelsverbände;" that is, those associations that have in view independently the object of increasing German foreign trade. These

associations must then appoint from among themselves one commission, which will be composed of representatives of all the organizations and which will direct all the associations.

Purposes of Suggested "Auslandamt."

As regards the widespread field of activity of this suggested association, covering all foreign (except political) questions, it is believed that it can be concentrated into one broadly-named association, such as "Auslandamt," which should attempt to accomplish the following:

1. Compilation of the laws and instructions regarding commerce, industry, mining, shipping, taxes, duties, patents, samples, trademarks, etc.
2. Compilation of commercial treaties.
3. Compilation of foreign, official, and other commercial statements of accounts.
4. Compilation of statistical material of trade and commerce.
5. Issuing of information regarding duties and tariffs.
6. Issuing of information regarding means of communication and rates.
7. Sending out of commercial experts.
8. Conducting of a registrar of purchases and sales and of a list of foreign attorneys.
9. Foundation of a bibliography of economic archives.
10. Publication of papers, both educational and others.
11. Formation of information bureaus and technical institutes for conducting commercial business.
12. Establishment of a warehouse for samples and the organization of exhibits.

In addition, the proposed association would establish abroad schools, German associations, foreign-study associations, and educational institutes; establish connections with various foreign associations; and maintain a card index of the Germans living abroad.

EDITOR'S NOTE—The following taken from the Commerce Reports is of interest regarding the continuation of German steel syndicates:

Various discussions and negotiations were carried on in 1917 concerning the prolongation or extension of the existing syndicates, particularly the Stahlwerks-Verband. A preliminary agreement was reached by the interested parties that the duration of the steel syndicate should be extended temporarily, perhaps to July 1, 1919; but the government made known its demand that the producers must unite, or the government would step in and exert pressure to keep them united.

The government is naturally interested in maintaining the syndicate during the transition period. The German iron industry will need effective protection in its struggle, on the one hand, against British and American competition in neutral countries, and on the other hand, against the countries now at war with Germany where the Germans would like to sell their wares again; and a strong organization is considered much more likely to achieve that end.

PRODUCTION TOPICS

CHECKING PYROMETERS.

Successful use of pyrometers requires some means of checking. The pyrometer is a precision gauge, but must withstand extremely severe conditions no matter how much care may be given to it. To be of practical value it must command respect for its accuracy. In the minds of the men who use it, it is in competition with a measuring instrument which, within its own limits, is quite reliable and upon which many men place great reliance, namely the human eye. The pyrometer, left to itself, may very easily become less accurate than the human eye and if it does the men who are using the pyrometer lose confidence in it, disregard its indications and trust to their own eyes even when the pyrometer is right.

This condition must be guarded against carefully if standards of product are to be maintained. Present day requirements as to quality require an accuracy and constancy in temperature control considerably beyond that possible with the human eye. Uniform results are possible only through the use of an accurate pyrometer, and the workmen must have confidence in and follow its indications. The most effective method of maintaining the workman's confidence is regularly to check all pyrometers, at such frequent intervals that there is no chance whatever that the workman will ever find the instruments wrong. This procedure has become the standard practice of many of the large manufacturing concerns during the past few years and it is a practice which is rapidly spreading.

Different pyrometer systems require different amounts of attention, but all may be handled by a standard checking method, and the most practicable method is that employed for checking many other instruments, namely, by comparison with a standard. The pyrometer may be considered as consisting of at least two, if not three parts independently liable to error and when an inaccuracy is discovered it must be traced to its source in the thermocouple, in the measuring instrument, or in the lead wires connecting the two. This article describes a method that has been found efficient and reliable for carrying out the necessary tests and suggests various equipments suitable for the work.

The method, in brief, provides first, for the maintenance of standards of temperatures in the plant and, second, for convenient comparison of these standards with the works instruments. The standard of temperature for the works should consist of at least one platinum-platinum 10 per cent rhodium thermocouple previously calibrated by the Bureau of Standards and a potentiometer. While it is possible to get along with one platinum couple it is most desirable that three platinum couples should be available for comparison, one against the other. The couple must of course, be subjected to high temperature when used and it is not impossible that it may change. If one couple only is available, such change will not be manifest to the operator until the damage due to faulty temperature determinations has been done. If only two couples are available and one changes, there is no way of telling which has changed. If, however, three couples are available and one changes it will be immediately apparent which one it is that has changed.

The platinum thermocouple which is used regularly for checking of the thermocouples should be mounted in a protecting tube with a mercurial thermometer in the head. The two other platinum couples can be unmounted and when

not in use can be kept in a safe. The mounted platinum thermocouple is used for calibrating secondary standard couples, which can be of the base metal type, and these standard base metal couples can be carried about in the works for checking thermocouples in working furnaces. Checks of the working standards against the fundamental standard should be made frequently enough to insure against faulty calibration. The stock of secondary standard base-metal couples which have been checked in the laboratory against the platinum couple also serves as a reserve for replacing works couples which are burned out. A number of the secondary standards can be checked up at once against the platinum couple.

The standard couple or couples should be used for standardizing purposes only, and with a potentiometer, since the potentiometer is the recognized and universally accepted standard instrument for electromotive force measurements. It should be so designed that its scale can accommodate with full sensitivity both platinum and base-metal couples. If potentiometers are used throughout the plant, so that there are other potentiometers available, one laboratory standard is all that will be required, since this may be checked against the works potentiometers, and if by chance the laboratory standard instrument should develop a flaw, it will be apparent, due to the fact that the works instruments will all deviate by the same amount from the standard. If the works instruments are millivolt-meters, there should be two laboratory potentiometers for checking against one another.

For use with the thermocouples and potentiometers there should be a large electric furnace having a zone of uniform temperature extending at least 12 inches, throughout which temperature variation is not in excess of 20°F. This furnace should have an internal cross section of not less than the equivalent of a circle 2 to 2½ inches in diameter.

All thermocouples to be used in the work should be checked in the laboratory furnace. The couple being tested is placed in the furnace with its hot junction in as close contact with the hot junction of the standard platinum couple.

DATA ON HEATING AND ANNEALING FURNACES.

(Continued from page 72.)

problem of proper size of furnace broadens from that of getting the heat into the steel to the more general problem of getting the heat both to the steel and to the furnace interior. The latter becomes heating surface in addition to that of the steel. If the flame is not luminous, the law of heat transmission by convection (explained before) holds. For furnace conditions, the heat transmission coefficients in the case of pure convection, range from 3 to 6 Btu/sq.ft., deg. F. and hour. If we compare this coefficient with the coefficient for total heat transmission into the steel, we readily see that the brick surface of the furnace interior over which the flames sweep and which in turn, radiates its heat to the steel, must be from four to six times the heating surface of the steel. If the brick surface is not of that extent, the coefficients of Fig. 4 cannot be maintained. Operators of furnaces know this fact quite well and try to maintain a "mellow" heat by having the luminous flame fill the whole furnace. In this attempt they frequently overreach themselves and burn much of the fuel after it has left the furnace.

NEWS OF THE PLANTS

The Manganese Steel Castings Company, Newton, near Norfolk, Va., is arranging for the construction of a new plant to cost about \$300,000. The company has acquired a site comprising about eight acres on the East branch of the Elizabeth river, for the proposed works, which will consist of furnace plant, with four 10-ton electric furnaces, moulding works, grinding plant, machine shop, pattern shop and other structures. The plant will be of steel frame and concrete construction, with initial capacity of about 40 tons of manganese castings per day. The works will also specialize in the production of steel car wheel rims, and castings for electric and steam railroad service. An electric power station will be erected for works operation, and a housing development for employes at the plant will be developed in this section. It is expected to commence active construction work early in the coming year. The General Contract Company, Citizens' Bank Building, Norfolk, has the contract for the building work.

The Hoosier Rolling Mill Company, Thirteenth street, Terre Haute, Ind., will build a one-story addition to its plant, including structures 52 x 210, 60 x 140 and 30 x 70 feet, for increased capacity. A. L. Greenberg is president.

The Wickwire Steel Company, River Road, Buffalo, N. Y., is planning to continue the operation of its works at present capacity, notwithstanding the close of the war, and is understood to be planning to increase its present working force. The company is reported to have orders on hand for the next eight months. The plant has recently devoted a large portion of its output to the production of barbed wire for the United States and Allied governments.

The Donner Steel Company, Abbott Road, Buffalo, N. Y., is planning for the construction of a number of additions to its plant, including a new plate mill. The structures will be one-story, 18 x 150, 18 x 135 and 18 x 90 feet, respectively, and estimated to cost \$30,000.

The Republic Iron & Steel Co., Youngstown, O., has completed repairs and improvements to its blast furnace No. 4, and increased the capacity from 450 to 500 tons. This furnace, located in the Mahoning Valley section, has now been blown in, and Furnace No. 2 shut down for repairs.

The Ludlum Steel Company, Watervliet, N. Y., is making improvements and extensions in its works to increase the capacity about 50 per cent. Two new 6-ton electric furnaces are being installed, making a total of four such furnaces at the works, with addition of three 10-ton furnaces and three 5-ton furnaces. A new 10-ton crane will also be provided to facilitate operations at the new furnaces. A new grinding department and annealing shops have recently been completed, the former to be devoted to the grinding of high-speed steel billets. This department will be provided with runways and equipment for handling heavy materials. The annealing works includes six 15-ton annealing furnaces, and it is planned to install two additional furnaces of oil-burning type for increased operations. A new inspection building has also been completed, including the installation of power hack saws, cranes and other equipment. A new 12,000-pound steam hammer has been placed in operation, with auxiliary crane and gantry equipment, with the addition of two new heating furnaces to be used in connection with operation of the hammer. For its 10-inch mill, the company has provided an electric motor drive, replacing the steam power heretofore in service. The hammer department also includes three 1,000- and

1,500-pound hammers. Since 1917 the company has increased the output of the local works over 100 per cent.

The Brier Hill Steel Company, Youngstown, O., is planning for the completion of its 132-inch mill, now in course of construction early in the coming year. The company has recently completed the erection of a new 84-inch mill. The company is now using electric service from the Mahoning & Shenango Railway & Light Company, a new steel tower transmission line, about 18 miles long, having recently been placed in service in this section of the Mahoning Valley.

The American Sheet & Tin Plate Company, Frick Building, Pittsburgh, Pa., has awarded miscellaneous contracts, including heating, plumbing, electric work, etc., for the completion of its new tin plate mill at Gary, Ind. Foundations for the plant, which is estimated to cost about \$10,000,000, have been completed.

The Crucible Steel Company of America, Pittsburgh, Pa., has inaugurated operations at its new plant at Auburn, N. Y., acquired recently under Federal court action from the Cayuga Tool Steel Company, Ltd. The property will be under the jurisdiction of the Syracuse, N. Y., works of the company, being used as a branch to this plant under the name of the Auburn Works of the Crucible Steel Company. The new plant will be devoted to high grade steel production and will be extended and improved for increased output. The company has perfected plans for the erection of a new building at its Harrison, N. J., plant.

The Milliken Brothers Manufacturing Company, Inc., Woolworth Building, New York, has commenced active work on laying out its new fabricating plant at One Hundred and Thirty-sixth street and East River, using the building of the James H. Young Stone Company at this location for the initial works. Former machinery has been removed and it is the intention to install a complete, modern equipment of steel fabricating machinery for the production of structural shapes for the manufacture of the company's specialties, including channels, angles, etc., as employed for the production of steel transmission towers, special standardized truss unit buildings, wireless towers and other products. On an adjoining plot a complete galvanizing plant will be erected. J. E. Jennings is vice president.

The American Bridge Company, Pittsburgh, Pa., has acquired a large tract of land totaling about 120 acres near West Elizabeth on the Monongahela division of the Pennsylvania Railroad, for the erection of a new plant for the production of structural steel shapes. Preliminary plans for the works are understood to be now under way, to include general manufacturing plant, shops, pumping plant for water supply and other structures. On an adjoining site, included in the purchase, it is proposed to develop a housing community for employes at the plant.

The Union Iron Works, Los Angeles, has removed the contracting and engineering departments of its business from the office in the Stimson Building to the main manufacturing works at 5125 Santa Fe avenue.

The Spokane, Wash., branch office of the Minneapolis Steel & Machinery Co. has been removed to 114-116 South Monroe street.

The R. H. Beaumont Company, Inc., Philadelphia, conveying and hoisting equipment, recently opened its new building at 315 Arch street.

Joseph T. Ryerson & Son, steel warehouse, Chicago, have opened an office in the Widener building, Philadelphia.

Some Pointers on By-Product Coke Oven Operations

THE BY-PRODUCT COKE OVEN AND ITS PRODUCTS

A. K. McCosh, Coatbridge, Scotland—It is well known in Great Britain that oven operators in the United States have been able to reduce the coking time much below European standards by the employment of higher temperatures. Our linings have always been the factor that has prevented our doing the same, and it would be of much interest to coke-oven operators here if Mr. Blauvelt would give a typical analysis of the bricks his company uses for the linings of its ovens, and if he could see his way to send me a sample so that I could have the texture examined, I should personally be very much obliged.

The lining brick which my company has found most successful is of a ganister variety, and has the following analysis: Silica, 80.8 per cent; alumina and iron oxide, 17.8 per cent; lime, 0.8 per cent; magnesia, 0.07 per cent; but with this brick the least carelessness on the gas regulator's part may destroy the lining.

It would also be of interest if Mr. Blauvelt could give the temperatures of the air leaving these generators and also of the oven flues.

I should be glad to know the life of the linings operated at these high temperatures. I have known oven linings to last as long as 10 years, and, in our case, if any lining fails before the end of seven years we consider that it has done badly. This is with washed coal containing about 12 to 15 per cent of free moisture, and charged by compressing machines.

As regards the size of ovens, the width and lengths given by Mr. Blauvelt are much the same as in this country, and the additional capacity is obtained by increasing the height. At a great number of the plants on this side, the coal is compressed before charging, and the maximum height of the charge is about 7 feet.

It would be interesting to know whether compressed charges are ever used in America and whether you find it feasible to compress a charge for an oven 12 feet high.

Has the construction of ovens longer than 36 feet ever been considered, and what is thought to be the limiting factor in this dimension?

Graham Bright, East Pittsburgh, Pa.—Bee-hive coke ovens are usually located at the mines, where the gases from the ovens are not strongly objectionable because the communities are not thickly built up. The by-product oven will naturally be located near centers of industry, to which the coal can be brought from different directions and desirable mixtures can be made; where also the by-products can be readily marketed, while the gas can be utilized for industrial and domestic purposes.

Not much thought seems to have been given to the gases escaping from the by-product coke oven, which are more or less objectionable in thickly populated sections. When the by-product oven shall have been more widely installed, this question is likely to become serious, and it will be necessary to apply remedies. May I ask what has been done, or is going to be done, in this direction?

S. A. Moss, Lynn, Mass.—One cause of escaping gas is that the gas exhausters do not supply the proper suction.

Discussion of the paper of W. H. Blauvelt, presented at American Institute of Mining Engineers' meeting.

If a satisfactory regulating governor is applied and the correct kind of gas exhauster is used, the trouble will be eliminated.

J. I. Thompson, Pittsburgh, Pa.—The Koppers Company has made a careful study of the question of smoke prevention. The smoke caused by the operation of the by-product coke ovens is infinitely less than that caused by bee-hive ovens.

The difficulties in preventing the last traces of smoke in by-product ovens are largely mechanical but are serious difficulties, considering that it is necessary to charge the 10 to 15 tons of coal into a heated oven in such a manner that no gas shall escape. The principal loss of gas occurs during this operation of charging the ovens when it is not possible to conduct all of the gas into the mains leading to the by-product apparatus.

A great deal of study is being given to this matter, and the Koppers Company has constructed a plant in St. Paul which is equipped with certain devices for correcting this nuisance. The method employed is to carry a portion of the escaping gases into the stack and discharge them high enough above the ground so that they will not be objectionable, while the remainder will be recovered and led into the by-product apparatus.

W. H. Blauvelt (author's reply to discussion)—The prevention of smoke from by-product-oven plants is not as simple as would appear from Mr. Moss's statement. All well designed by-product-oven plants are equipped with ample exhauster capacity, and the suction on the ovens is controlled by highly sensitive pressure governors that control the pressure within a fraction of a millimeter. Of course, this apparatus can get out of order, causing the batteries to smoke, but this does not often happen.

As stated by Mr. Thompson, the smoke produced is made almost entirely during the time of charging the ovens, when they are cut off from the hydraulic main. The amount of smoke that escapes at this time is extremely small, compared with the amount produced by a beehive-oven plant, but the mechanical difficulties in preventing any escape of smoke at charging time are considerable. Several devices are in operation at a number of plants which collect most of the smoke made during charging and several devices are being worked on for its complete elimination. These will probably be employed only where the smoke is objectionable on account of the location of the plants, as the value of the by-products in this smoke is very small.

NEW COKE PLANTS.

The Pittsburgh Crucible Steel Company, Midland, Pa., has commenced the construction of a large battery of coke ovens at its local works, for coke supply for blast furnaces and gas supply for steel mill operation. The installation will comprise a total of 100 ovens.

The Granby Consolidated Mining Company, Anyox, B. C., has commenced the erection of a new battery of coke ovens at its local steel works. It is also proposed to build a large power plant for mill and other operating facilities.

A special report has been tendered to the city council, Buffalo, N. Y., by an investigating committee, recommending the establishment of a coke works for municipal operation.

INDUSTRIAL RELATIONS

AT ATLANTIC CITY CONVENTION.

The great importance of industrial relations and need for the consideration and thought to be given this essential subject was probably never more pronounced than at the closing of the war service committees held under the auspices of the Chamber of Commerce of the United States at Atlantic City, N. J., December 4, 5 and 6. This gathering, known as a reconstruction congress, brought together a total of 381 war service committees, and with other prominent business and industrial men, an aggregate attendance of over 100. Addresses were made by Charles M. Schwab, John Rockefeller, Jr., William B. Dickson, William C. Redfield, secretary of commerce; Harry A. Wheeler, president of the chamber of commerce, and others. Quite naturally from these leaders of industry one might expect an expression of views of valuable and authoritative status regarding industrial relations—opinions that mean something, opinions that convey in a nutshell the far-reaching significance of this subject, and such as to bring about a better understanding between capital and labor.

First and foremost in this connection is the industrial creed propounded by Mr. Rockefeller and which has been adopted far and wide as striking a new keynote in that line of industrial activity which deals with the employer-employee and the relations existing between the two. At this creed, which follows, met the full accord of those present, was evident from the enthusiastic and continued applause which greeted the speaker.

Industrial Creed.

Labor and capital are partners, not enemies; their interests are common interests, not opposed, and neither can attain the fullest measure of prosperity at the expense of the other, but only in association with the other.

The purpose of industry is quite as much to advance the well-being as material well-being, but in the pursuit of that purpose the interests of the community should be fully considered, the well-being of the employees as regards living and working conditions should be fully considered, management should be adequately recognized and rewarded, and labor should be justly compensated and failure in any of these particulars means less to all.

Every man is entitled to an opportunity to earn a living, to fair wages, to reasonable hours of work and proper working conditions, to a decent home, to the opportunity to learn, to worship, and to love, as well as to toil, and the responsibility rests as heavily upon industry as upon government or society, to see that these conditions and opportunities prevail.

Industry, efficiency and initiative, wherever found, should be encouraged and adequately rewarded, and indifference and restriction of production should be uncountenanced.

The provision of adequate means for uncovering advances and promptly adjusting them, is of fundamental importance to the successful conduct of industry.

The most potent measure in bringing about industrial harmony and prosperity is adequate representation of all parties in interest; existing forms of representation should be carefully studied and availed of insofar as they can be found to have merit and adaptable to the peculiar conditions of the various industries.

The application of right principles never fails to bring about right relations; the letter killeth and the spirit maketh alive; forms are wholly secondary, while attitude and spirit are all important, and only as the parties in industry are animated by the spirit of fair play, justice to all and brotherhood, will any plans which they may mutually work out succeed.

That man renders the greatest social service who so

cooperates in the organization of industry as to afford to the greatest number of men the greatest opportunity for self-development and the enjoyment by every man of those benefits which his own work adds to the wealth of civilization.

In line with these principles, the general attitude of the gathering was one of cooperation with labor; to bring about harmonious and right conditions where such might not exist, and to discuss at a common council the ways and means for attacking the vital problems now before the industrial world as a unit. Well organized labor, rightly organized labor gives evidence of an earnest desire to work hand in hand for common good and better understanding. The contented and satisfied workman is an asset, while the reverse holds true of the employe who engages practically as a "floater" and brings neither gain nor satisfaction to himself or his employer.

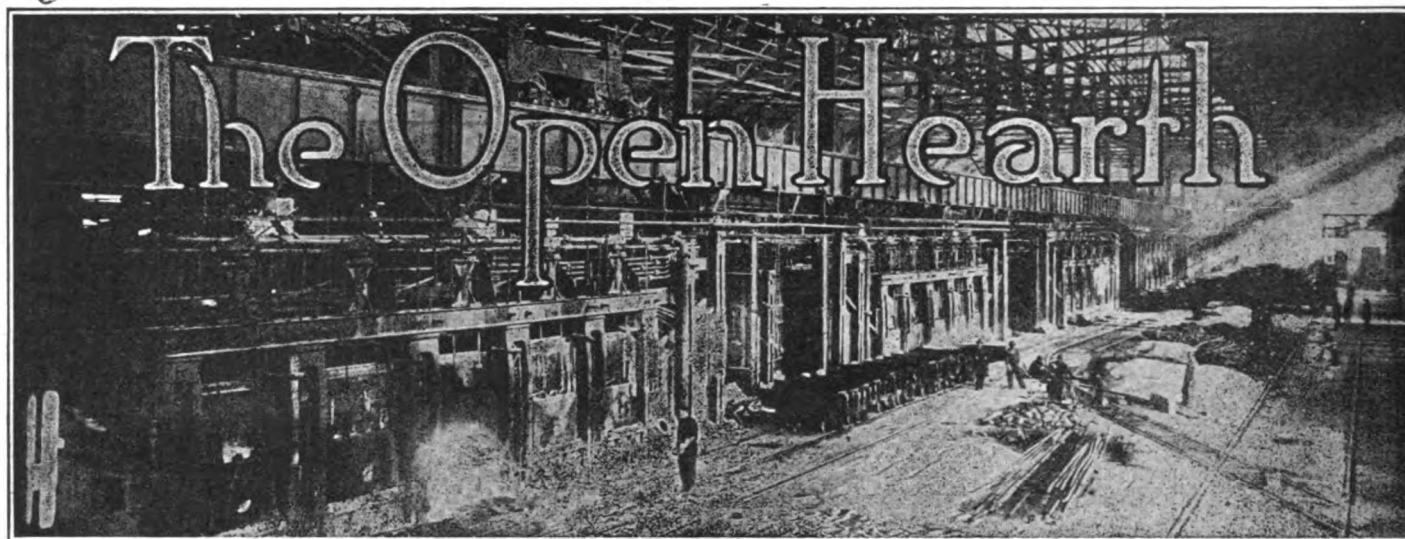
Coincident with this thought, William B. Dickson, vice president of the Midvale Steel & Ordnance Co., at one of the conferences, pointed out that the day of the autocratic employer has passed and that a real menace to congenial relations is the demagogic labor leader, who, for his own selfish purposes, plays upon the ignorance, prejudice and credulity of his fellows. As regards the matter of wages and present schedules, Mr. Dickson said:

"The fact that, after all, the real measure of wages is not the sum received, but the purchasing power of that sum, ought to be a platitude which any public speaker should be ashamed to utter in the presence of intelligent men. The fact remains, however, that this fundamental truth is not generally appreciated, either by wage earners or wage payers."

Mr. Dickson is of the opinion that there should be no attempt at arbitrary reduction of wages, and unquestionably this was the view and standpoint taken by the majority of those in attendance. If prices of commodities are too high, as Mr. Dickson set forth, they must be reduced to the point where manufacturers, or consumers, will be encouraged to buy, and then wages under the irrevocable law of supply and demand will seek and find their natural level. Employers, on one hand, should realize that while the wages which they are paying may seem very high as compared with previous levels, there may not be very much of an advance when these wages are translated into the terms of purchasing power. Employees and wage earners, on the other hand, will come to find that high wage rates, while very pleasant sounding to the ear, are only effective when translated by actual work into wage payments.

In a program of readjustment to pre-war conditions, wage scales should be the last factor of operation to be affected, and in justice to the worker, insofar as possible, the present basis should be maintained until the purchasing power of a dollar advances. On the other hand, overtime must cease, and a return made to the principle of the eight-hour day.

A like viewpoint to that expressed was taken at a meeting of the Manufacturers' Council of the State of New Jersey at a special meeting at Newark on December 11. Here representatives of labor so expressed themselves, holding that organized labor welcomes the return to the regular eight-hour day or 44-hour week and the elimination of overtime. At this meeting, the first of its kind not only in New Jersey but in any state of the Union, a resolution was adopted embodying the principle of no wage reduction until necessity might compel.



The following have been elected to membership in American Iron and Steel Institute:

Active membership—Edward Thomas Butler, Trumbull Steel Company, Warren, O.; Whiteford R. Cole, president Napier Iron Works, Fourth and First Bank Building, Nashville, Tenn.; Stewart J. Cort, Bethlehem Steel Company, South Bethlehem, Pa.; L. C. Crewe, LaFollette Coal & Iron Co., LaFollette, Tenn.; Charles F. Fairbanks, 304 Sears Building, Boston, Mass.; Samuel Lewis, Bethlehem Steel Company, South Bethlehem, Pa.; William H. Lindsey, vice president Napier Iron Works, Fourth and First Bank Building, Nashville, Tenn.; Henry R. Moore, Republic Iron & Steel Co., Youngstown, O.; J. M. Overton, president Suwanee Iron Company, Nashville, Tenn.; Harry Wharton Summers, Carnegie Steel Company, 1734 Widener Building, Philadelphia, Pa.

Associate membership—H. F. Ambrose, Standard Iron Company, 305 Church street, Nashville, Tenn.; Edgar F. Blessing, Doehler Die Casting Company, Cortlandt and Ninth streets, Brooklyn, N. Y.; James A. Green, president the Matthew-Addy Company, Cincinnati, O.; L. F. W. Hildner, vice president Pittsburgh Bridge & Iron Works, 1205 Farmers Bank Building, Pittsburgh, Pa.; George E. Klingelhofer, president Pittsburgh Bridge & Iron Works, 1205 Farmers Bank Building, Pittsburgh, Pa.; Thomas A. Arthur, vice president Hickman, Williams & Co., 1343 Oliver Building, Pittsburgh, Pa.; Arthur Forbes Braid, Metal & Thermit Corporation, 120 Broadway, New York, N. Y.; Frank H. Guppy, secretary Mothrup Steel Products Company, Beaver Falls, Pa.; Julian Kahn, president, Truscon Steel Company, Youngstown, O.; C. Douglas Mercer, Clinton Wire Cloth Company, 304 Sears Building, Boston, Mass.; James T. Mothrup, president Mothrup Steel Products Company, Beaver Falls, Pa.; Joseph Richard Rogers, president A. Haukey & Co., Inc., Rochdale, Mass.; Quincy W. Wales, Brown-Wales Company, 493 C. street, Boston, Mass.; Thomas Coleman Ward, president Hickman, Williams & Co., 1344 Oliver Building, Pittsburgh, Pa.; Charles D. Rawsthorne, vice president Freyn, Brassert & Co., 643 Peoples Gas Building, Chicago, Ill.; Mowry P. Simpson, vice president Mothrup Steel Products Company, Beaver Falls, Pa.; Frederick W. Walters, Steel Sales Corporation, 129 South Jefferson street, Chicago, Ill.; I. Fenwick Young, president Young & Vann Supply Co., 1731 First avenue, Birmingham, Ala.

William B. Topping, assistant general sales manager for the Republic Iron & Steel Co., Youngstown, O., has been made general sales manager, with offices in Youngstown.

Charles T. Johnston, general sales manager for the Republic Iron & Steel Co., has been transferred to Pittsburgh, to be general agent.

Charles W. Stoup, manager of the Norwalk works for the Crucible Steel Company of America, has been elected vice chairman of the Norwalk Manufacturers' Association.

H. A. Wilder has been appointed purchasing agent of the Heppenstall Forge & Knife Co., Pittsburgh, Pa.

Louis W. Adams has been appointed works manager of the open hearth and mills department for the Ashland Iron & Mining Co., Ashland, Ky.

C. E. Scheuring, superintendent of the Fort Wayne branch of the American Road Machinery Company, has resigned to become works manager for the Insley Manufacturing Company, Indianapolis, Ind.

R. H. Wilson, Houston, Tex., representative for the Walter A. Zelnicker Supply Company, St. Louis, has been appointed assistant to the president. E. O. Griffin succeeds Mr. Wilson in the Houston office.

T. J. Titner has resigned as superintendent of the 14, 16 and 34-inch rolling mills, at the Steelton, Pa., plant of the Bethlehem Steel Company.

R. W. Knight, contracting engineer for McClintic-Marshall Company and Riter-Conley Company, in the Pittsburgh district, has been placed in charge of the sales offices, 50 Church street, New York, for the McClintic-Marshall Export Company.

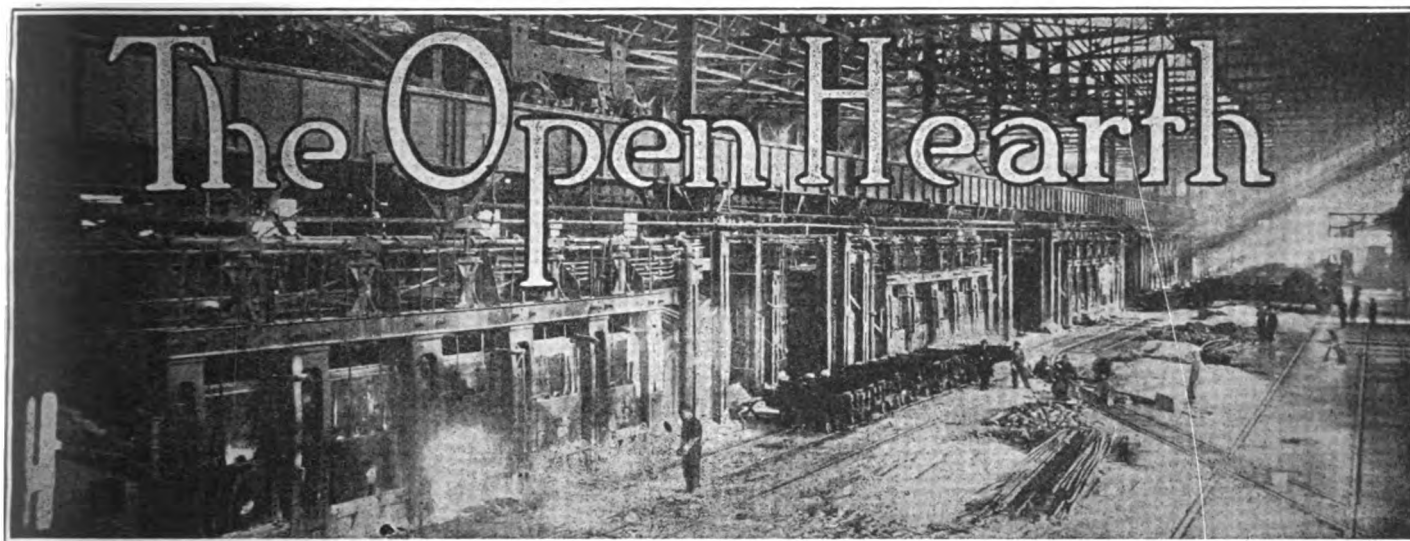
B. C. Sawyer, salesman for the Carnegie Steel Company in the Cleveland district has resigned and accepted a position with the Quebec Engineering Company, Bethlehem, Pa.

Charles O. Rowe, district representative for the Hess Steel Corporation, has been placed in charge of the branch office at 517 Widener Building, Philadelphia, recently established by the company.

R. W. Knowles, formerly chief engineer and factory superintendent for the Electric Products Company, Cleveland, has been appointed assistant to John H. Hertner, chief engineer for the R. & L. Baker Co., Cleveland, O.

Bertram S. Stephenson has resigned as assistant to Jay C. McLaughlan, chief of the pig iron section of the steel division of the War Industries Board, and resumed his former position as Pittsburgh district manager of sales for M. A. Hanna & Co., Cleveland, O.

W. C. Kennedy, steam and electrical engineer for the Pittsburgh Crucible Steel Company, at Midland, Pa., has resigned and accepted the position of operating engineer in charge of steam, mechanical and electrical departments for the Worth Steel Company, Claymont, Del.



Clarence H. Howard, president Commonwealth Steel Company, has been appointed by Mayor Henry W. Keil, of St. Louis, on the Municipal Reconstruction Committee.

✓ ✓

Verne W. Aubel, recently returned from blast furnace work in New Zealand and Australia, has accepted a position as assistant superintendent of blast furnaces at the Clairton plant of the Carnegie Steel Company.

✓ ✓

Harold L. Frankle, formerly supervisor of the scrap yards at Norfolk, Va., for the Joseph Joseph & Brothers Co., New York, has opened offices at 1051 Ellicott Square Building, Buffalo, to engage in a scrap iron and steel brokerage business.

✓ ✓

J. H. Porter, president of the Calumet Steel Co., Chicago, who has been in the government service, has resigned his administrative office at the Rock Island arsenal and returned to the Calumet company. His duties will be performed by Lieut. R. C. Mitchell.

✓ ✓

Henry Cave, factory manager for the S. K. F. Ball Bearing Company, Hartford, Conn., has resigned and will be succeeded by R. T. Runge.

✓ ✓

B. A. Ployd has recently been appointed to a position in the Philadelphia sales offices for the Brier Hill Steel Company, Youngstown, O.

✓ ✓

Charles Sullivan, formerly with the Westinghouse Electric Manufacturing Co., has been made district manager at Pittsburgh, for the Milwaukee Electric Crane & Manufacturing Co.

✓ ✓

J. W. Powell, vice president of the Bethlehem Steel Corporation, Philadelphia, has been elected vice president of the National Society of Naval Architects and Marine Engineers, at its twenty-fifth annual meeting in Philadelphia.

✓ ✓

J. C. Fitzpatrick has recently resigned as manager of the construction machinery department of Gaston, Williams & Wigmore, Inc., 39 Broadway, New York, to accept the position of assistant to the president of the American Condenser & Engineering Corporation, 120 Broadway.

✓ ✓

Judson T. Whitehead has been elected president of the Machinery & Metal Sales Company, 42 Broadway, New York, to succeed George T. Baird.

Brig.-Gen. Guy E. Trip has resigned from military service and resumed his duties as chairman of the board of the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa.

✓ ✓

Norman P. Farrar, for many years district manager of the Philadelphia territory for Shepard Electric Crane & Hoist Co., has been placed in charge of the office recently opened in Baltimore, Md.

✓ ✓

Horace N. Trumbull, who has recently received his discharge from the Engineers Officers' Training School, at Camp A. A. Humphreys, Va., has been appointed advertising manager of the Wellman-Seaver-Morgan Company, at Cleveland, O. Before entering the service, Mr. Trumbull was advertising manager of the SKF Ball Bearing Company, at Hartford, Conn.

✓ ✓

Allen Fraser, eastern sales manager for the Wickwire Steel Company, has been placed in charge of the office, recently opened by the company in the Equitable Building, 120 Broadway, New York City.

✓ ✓

A. Robertson has succeeded W. C. Fletcher as manager of the American Steel Foundries plant at Sharon, Pa. A. D. Allen, production manager becomes assistant to Mr. Robertson.

✓ ✓

Harvey H. Brown has been elected chairman of the board of directors of the Brown Hoisting Machinery Company, Cleveland.

✓ ✓

George E. Cullinan, district manager for the Western Electric Company, St. Louis, since 1916, has been appointed manager of the central district, with offices in Chicago, to have charge for the company in 12 states. H. N. Goddell, formerly manager of the Omaha branch, succeeds Mr. Cullinan.

✓ ✓

George E. Day, a director of the Youngstown Sheet & Tube Co., has relinquished his duties as director of the Bureau of Oil Well Supplies, New York.

✓ ✓

Joseph H. Frantz, vice president and general manager of the Columbus Iron & Steel Co., Columbus, O., is on a readjustment committee with H. K. Raymond, Akron, O., and Charles King, Marion, O., appointed by the National Association of Manufacturers. Stephen C. Mason, of Pittsburgh, president of that organization, presided over a recent meeting of the committee, called to consider the matter of employment for returned soldiers.

WITH THE EQUIPMENT MANUFACTURERS

TOOL STEEL BOOKLET.

Careful experiments which have been made by Carnegie Steel Company in its own machine shops and in actual use at its various works indicated that there are many purposes where a well-made carbon tool steel can be utilized in the manufacture of tools where heretofore alloy steels have been utilized. It has been possible by the use of carbon steels to reduce the cost of machine and other tools without material loss either in endurance or in speed of operation.

On the basis of these experiments and considerations the Carnegie Steel Co. is now prepared to offer to the trade a new line of tool steels made in its electric furnace at Duquesne steel works in five grades. These five grades contain different proportions of carbon, are suitable for different uses and in manufacture and shipment are distinctively designated by appropriate labels of different colors. To introduce these tool steels it has issued a new publication entitled: "Tool Steels."

In connection with the pamphlet the distinctive features are:

The pamphlet is intended for the actual user of tool steels, and, therefore, contains essential practical information without an extended discussion of the theories of heat treatment. The words "critical temperature" and "critical range" have been eliminated with all the theoretical discussions of austenite, troostite, sorbite, pearlite, cementite, etc., and their transformations which clutter much of the current literature. In lieu of these designations reference is had to "line of hardening" and "minimum grain size" which after all are the essential points in the heat treatment of steels.

In standard works of reference on metallography and heat treatment, it is possible to find figures illustrating the changes which take place in various kinds of steels under heat treatment. These, however, are, as a rule, steels of different carbon content, alloy steels, etc., so that a direct comparison is not possible. The illustrations of the Metcalf test pieces and the full size test piece fractures on pages 8 and 9 are made from specimens treated and tested at the Carnegie shops for purposes of publication in this pamphlet, and, therefore, admit direct comparison. The man who would test Carnegie electric tool steel No. 1 in the manner indicated should get identical results.

The chart of heat colors with its corresponding heat treating temperatures are in like manner based on carbon steels. Names of colors have been selected to conform to most general uses and are checked by indication of temperature in degrees Centigrade and Fahrenheit.

The chart of temper colors in the form presented is likewise entirely new. It is a direct reproduction by color photography from test pieces heat treated to the temperature shown. The pages devoted to reproduction of labels also specify the various uses for each different grade of steel and permit the selection of the proper grade for any particular use with the least danger of the selection of the wrong kind of material.

METALLURGICAL SOCIETY FORMED.

The needs for a metallurgical society exclusively confined to that branch dealing with steel, iron and their alloys, has been keenly felt for a long time. Several of the metallurgists prominently connected with this branch have from time to time expressed themselves to this effect. Recently these expressions have resolved themselves into something more tangible, viz., a meeting of about six or seven metallurgists to discuss the matter in a definite way. This meeting was recently held in the Fort

Pitt Hotel, Pittsburgh, when the formation of this society was decided upon. Its aim and objection is the promotion of the arts and sciences connected with the metallurgy of iron, steel and their alloys.

A committee to consummate the plans of this meeting was appointed and D. L. Mathias, of Mackintosh, Hemphill & Co. was selected as chairman. This committee is now preparing the necessary data, and taking steps to materialize the society.

At present the membership is composed of a very small coterie. Before the society can be a real force, the active co-operation of those eligible for membership will, of course, be needed. The committee mentioned above will be very pleased to answer any inquiries from, and furnish information to, those interested.

SMOKE PREVENTION, COAL SAVING SUGGESTIONS

Just at this time when the conservation of coal is an absolute necessity, everyone realizes that smoke issuing from boiler stacks represents unused heat units, but everyone does not realize that certain simple rules, if observed in the fire room, will materially decrease this loss. The suggestions herein are based on many years' experience of the Westinghouse Electric & Manufacturing Co.'s combustion engineers and are briefly outlined below:

1. Give your fireman an opportunity to acquire the fundamental principles of fuel burning.
2. If you have a difficult fuel problem, consult a combustion engineer.
3. Prevent smoke by proper firing methods.
4. Use gauges to indicate exactly the condition of firebed at all times. As a minimum these gauges should consist of draft gauge indicating draft in furnace above fuel bed, draft gauge indicating draft at boiler side of flue damper and a steam flow meter for individual boilers.
5. CO₂ is the principle product of complete combustion of coal. Ten to 12 per cent CO₂ should be obtained in flue gases to insure minimum fuel loss.
6. Avoid loss due to unburned coal in the ash.
7. If you are wasting exhaust steam, you are wasting coal.
8. Do not permit grates to clog. A systematic method of keeping the air spaces clean must be followed.
9. Inspect the baffles in boilers as broken or leaky baffles raise the flue gas temperature and waste coal.
10. Avoid leaking in of cold air around boiler setting.
11. Install stokers. Hand firing is rapidly being recognized as an obsolete and wasteful method of firing.
12. Clean scale from tubes as every particle of scale represents wasted coal.
13. Avoid soot formation. All boiler tubes should be blown externally once every eight hours when in continuous service.
14. All smoke flues should be as short and straight as possible. Flues should also be made air tight and all joints and connections should be well fitted, caulked and riveted. Use asbestos gaskets on cleanout doors.
15. Locate flue dampers in front of boiler so that fireman will adjust them as required. Dampers located in rear of boilers are seldom disturbed regardless of conditions.
16. The size of coal has much to do with capacity and efficiency of boilers. In general, the air pressure penetrates

WITH THE EQUIPMENT MANUFACTURERS

the fuel bed formed by coarse coal easier than that formed by finer coal, resulting in disturbance of best furnace conditions.

In addition to the above suggestions, the following "don't fail to do" list should be followed.

Don't fail to:

Keep the heating surfaces of the boilers free from soot, scale or oil.

Keep the fires level and free from holes.

Do not carry the fires so thin as to draw a lot of excess air through.

Do not carry the fires so thick as to have incomplete combustion of the coal.

Do not soak the coal with water before firing.

Be sure the blow-off valves do not leak.

Do not have the safety valve popping off continually.

Cover steam pipes.

Do not waste steam through leaky valves or traps.

Never use live steam if exhaust steam is available and can be used as well.

An observance of the foregoing simple rules and suggestions should materially reduce the coal consumption of the average plant.

INSPECTION OF METALLIC ELECTRODE ARC WELDS.

O. S. ESCHOLZ, Research Engineer.

Determining the character of welded joints is of prime importance, and the lack of a satisfactory method, more than any other factor, has been responsible for the hesitancy encountered among the engineering profession toward the extensive adoption of arc welding. To overcome this prejudicial attitude it is eminently desirable to shape our rapidly accumulating knowledge of operation into an acceptable method of inspection.

Manufactured apparatus is practically all accepted on the basis of complying with a process specification rigidly enforced in conjunction with the successful reaction to certain tests applied to the finished product. Riveting, it is commonly known, seriously impairs the strength of the joined plates, yet with a proper layout and intelligent inspection, the completed structure possesses certain definite characteristics which do not require further verification. The inspector of a finished concrete structure is practically helpless. The weakest sort of construction may be concealed by a sound surface it is quite possible. With a careful supervision of the process, however, the physical properties of the completed structure can be readily gauged to the extent that its use is justified even in ship construction. With this in view, it is satisfying to realize that electric arc welding is susceptible to even better control than either of these structural operations.

How to Determine the Character of a Weld.

The four factors which determine the physical characteristics of the metallic electrode arc welds are; fusion, slag content, porosity, and crystal structure.

Some of the other important methods that have been suggested and used for indicating these characteristics are:

- 1—Examination of the weld by visual means to determine;
 - a—Finish of the surface as an index to workmanship.
 - b—Length of deposits, which indicate the frequency of breaking arc, and therefore, the ability to control the arc.
 - c—Uniformity of the deposits, as an indication of the faithfulness with which the filler metal is placed in position.

d—Fusion of deposited metal to bottom of weld scrap as shown by appearance of under side of welded joint.

e—Predominance of surface porosity and slag.

2—The edges of the deposited layers chipped with a cold chisel or calking tool to determine the relative adhesion of deposit.

3—Penetration tests to indicate the linked unfused zones, slag pockets and porosity by:

a—X-ray penetration.

b—Rate of gas penetration.

c—Rate of liquid penetration.

4—Electrical tests (as a result of incomplete fusion, slag inclusions and porosity), showing variations in:

a—Electrical conductivity.

b—Magnetic induction.

These tests if used to the best advantage would involve their application to each layer of deposited metal as well as to the finished weld. This excepting in unusual instances, would not be required by commercial practice in which a prescribing welding process is carried out.

Of the above methods the visual examination is of more importance than generally admitted. Together with it, the chipping and calking tests are of particular usefulness. The latter test serves to indicate gross neglect by the operator of the cardinal welding principles, due to the fact that only a very poor joint will respond to the tests.

The most reliable indication of the soundness of the weld is offered by the penetration tests. Obviously, the presence of unfused oxide surfaces, slag deposits and blow holes will offer a varying degree of penetration. Excellent results in the testing of small samples are made possible by the use of the X-ray. However, due to the nature of the apparatus, the amount of time required and the difficulty of manipulating and interpreting results, it can hardly be considered at the present time as a successful means to be used on the large scale production.

The rate that hydrogen or air leaks through a joint from pressure above atmospheric, or from atmospheric to partial vacuum can readily be determined, by equipment which would be quite cumbersome, and the slight advantage over liquid penetration in time reduction is not of sufficient importance to warrant consideration for most welds.

Kerosene, of the various liquids that may be applied, has marked advantages, due to its availability, low volatility and high surface tension. Due to the latter characteristics, kerosene sprayed on a weld surface is rapidly drawn into any capillaries produced by incomplete fusion between deposited metal and weld scrap, or between succeeding deposits, slag inclusions, gas pockets, etc., penetrating through the weld and showing the existence of an unsatisfactory structure by a stain on the emerging side. A bright red stain can be produced by dissolving suitable oil soluble dyes in the kerosene. By the means of this test, the presence of faults have been found that could not be detected with hydraulic pressure or other methods. By the kerosene penetration, a sequence of imperfect structures linked through the weld, which presents the greatest hazard in welded joints, could be immediately located. It must be borne in mind, however, that this method is not applicable to the detection of isolated slag or gas pockets, nor small disconnected unfused areas. It has been shown by various tests, however, that a weld may contain a considerable amount of distributed small imperfections, without affecting, to a great extent its characteristics.

If a bad fault is betrayed by the kerosene test, it is advisable to burn out the metal with a carbon arc before rewelding under proper supervision.

Trade Notes

The Electric Furnace Company has just closed a contract with the Braeburn Steel Company, Braeburn, Pa., for a large continuous recuperative annealing furnace, for the annealing of alloy steel bars and wire. This furnace will have a capacity for annealing 75 tons per day, and an electrical capacity of 600 kw.

The Wellman-Seaver-Morgan Company of Cleveland, Ohio, has opened a San Francisco office at 415-417 Rialto Building, in charge of Mr. Norman S. Ross. Business originating from California, Nevada west of the one hundred and fifteenth meridian, lower California and the counties of Josephine, Jackson and Klamath in Oregon, will receive the prompt attention of Mr. Ross.

The Youngstown Sheet & Tube Co.'s annual calendar for 1919 is out, and is, perhaps, the handsomest of the interesting series issued by that company. It contains 12 new views, 8x15 inches, in two colors, each showing one of the spectacular operations in a modern steel mill. The illustration on the front page is a night view of the main plant while it was speeded up on war work and flood-lighted as a war-time precaution. This remarkable picture was made from a photographic plate which had been exposed two hours and is regarded as a triumph of night photography. The calendar will be sent to any address on receipt of four cents in stamps to pay expense of mailing. Requests for it should be addressed to the Publicity Department, Youngstown Sheet & Tube Co., Youngstown, O.

Discussing the prospects for the year 1919 at the Essington or South Philadelphia works of the Westinghouse Electric & Manufacturing Co., R. B. Mildon, assistant to the vice president, made the following statement. "We share the general opinion in the industrial field that business will slow down somewhat owing to the readjustment of the industries from a war to a peace basis; but by spring this phase should be over and then for the next few years we should have a period of prosperity. As far as the Westinghouse works at Essington is concerned, we have enough orders on hand to keep us busy for the next year without considering new business which is now beginning to develop. We are at present making nothing here but ship propulsion machinery, but our plans contemplate bringing here all of our turbine and electric generator construction work that is now being handled at East Pittsburgh. Before we can accommodate this additional business, however, we shall have to build several new buildings, including an office building, a shop for making turbine blades, and an electric generator shop. Unless we are mistaken in our expectations, however, this new construction work should begin this spring. Looking a little further ahead into the future it is probable that we shall in time erect a building for the

construction of electric locomotives. The electric railroad situation is unquestionably very favorable and a large amount of electrification will be undertaken in the next 10 years. We cooperate with the Baldwin Locomotive Works in the manufacture of electric locomotives and our location here, so close to the Baldwin plant, makes this the proper place to do our part of the work. In other words, we plan to build at Essington all of our large and important apparatus, and as the demand for this class of apparatus is certain to increase rapidly from year to year, we expect to see our plant expand in the near future to many times its present size."

Trade Publications

Electrical Heat—"Miscellaneous Applications of Electrical Heat by Means of Standardized Units," is the title of a new four-page descriptive pamphlet being distributed by The Cutler-Hammer Manufacturing Company of Milwaukee. These standardized heating units are known as C-H space heaters. They are about the same size as two feet of lath. The blueprint which accompanies the new pamphlet gives all the dimensions of these standardized units. The pamphlet makes special mention of the great variety of applications of these units, important among which are: Crane and hoist cabs, meter houses, watchman houses, detached or exposed rooms, storage house offices, freight house offices, temporary construction offices, valve houses, sprinkler riser houses, mines, where explosives are present, where open flame would be dangerous, for keeping oils free to flow, drying rewound motor armatures, for table men and shear men in steel plants, for keeping automobile and motor truck engines warm.

Pumps—The A. S. Cameron Steam Pump Works, New York, has issued a 12-page booklet, in which pumps for marine service are fully described and illustrated. This bulletin contains sectional and complete views, as well as full descriptions and tables.

Annealing Furnaces—A type of furnace used for bright annealing copper wire, brass copper, phosphor bronze, cartridge cases and similar products, is described and illustrated in a 4-page pamphlet recently issued by the W. S. Rockwell Company, New York City. The booklet contains several excellent illustrations of the furnace in operation together with a detailed description of its construction and operation.

Starting Switch—An attractive two-page leaflet recently was issued by the Cutler-Hammer Manufacturing Company, Milwaukee, in which starters for squirrel-cage motors are described. The operating handle of the starter is outside the enclosing case, and may be locked in the "off" position if desired to prevent operation during repairs to the

motor or machine. The machine embodies practically all safety precautions in the running of electrical machinery.

Melting Furnaces—A bulletin recently issued by the W. S. Rockwell Company, New York, describes and illustrates the company's line of tilting, reverberatory melting furnaces for non-ferrous metals. The furnaces are made in capacities ranging from 500 to 2,000 pounds. One of the latest types described is a mechanically operated tilting furnace with a nominal capacity of 2,000 pounds. Tilting is accomplished by means of an air hoist, the furnace pivoting about an axis running through the pouring spout.

Burners—Oil and gas burning equipment is thoroughly described and illustrated in a 12-page booklet recently issued by the Gwynn Engineering Company, Pittsburgh. The gas burner is equipped with a quick-opening, indicating-dial gas valve, which provides a handy appliance and time saver. Other equipment of oil and gas burning devices are described.

Industrial Buildings—An attractive booklet, in which standardized commercial and industrial buildings are described and illustrated is being circulated by the Gaylord W. Feaga Company, construction engineers, Cleveland. The book tells of intensive effort in industrial construction, the standardization of factory buildings, and speed in erecting buildings of permanent qualities. The booklet gives a list of clients of the company, many of which are iron and steel producers.

Gas Valves—The Steere Engineering Company, Detroit, recently published a 16-page catalog, with a supplement in which gas valves and welded steel pipe, manufactured by the company, are fully described and illustrated. The principal dimensions of valves as well as the standard dimensions of welded steel fittings are given. The standard dimensions of welded pipe and flanges are also given. The catalog supplement contains a number of illustrations showing typical views of welded and riveted construction done by the company.

Society Meetings

International Mining Convention, auspices Vancouver chamber of mines, Vancouver, B. C., January 8-10.

American Society of Civil Engineers, New York, N. Y., January 15-16.

American Wood Preservers Association, St. Louis, Mo., January 28-30.

American Society of Heating and Ventilating Engineers, New York, N. Y., January 28-30.

American Institute of Mining Engineers, New York, N. Y., February 17-20.

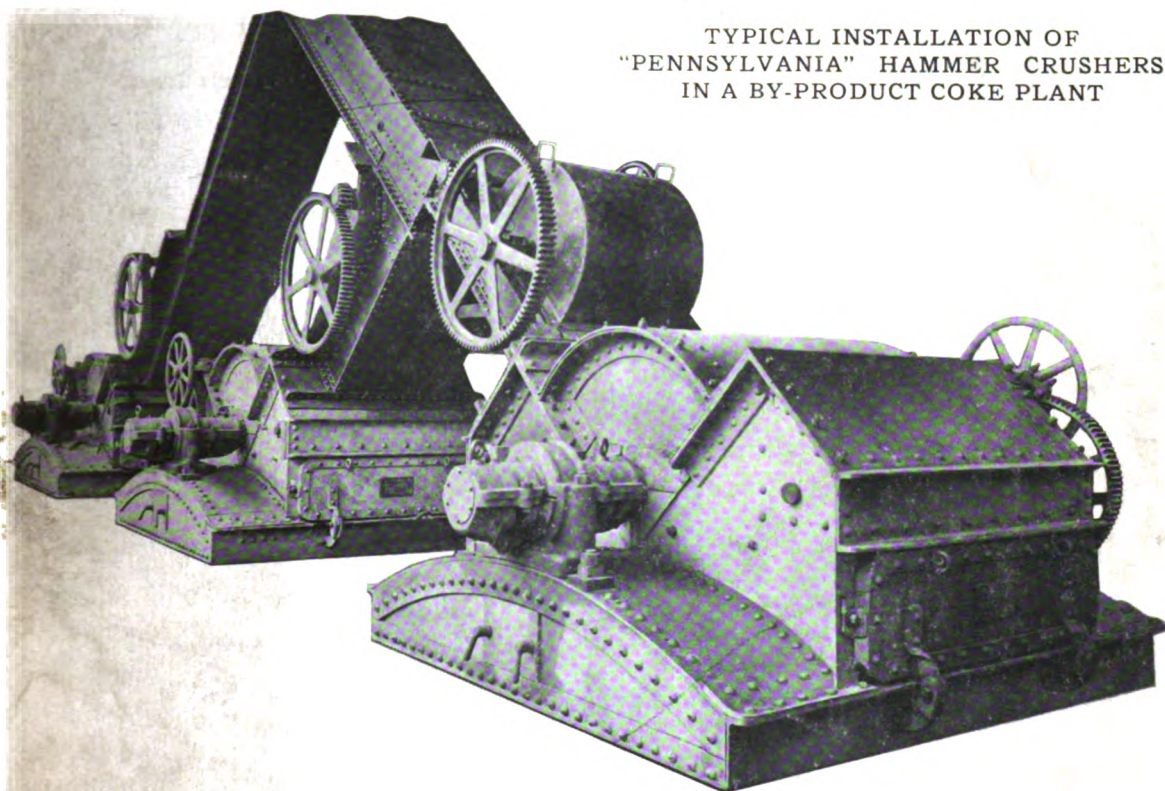
New England Association of Gas Engineers, Boston, Mass., February 19.

American Railway Engineering Association, Chicago, Ill., March 18-20.

The Blast Furnace *and* Steel Plant

Pittsburgh, January, 1919.

TYPICAL INSTALLATION OF
"PENNSYLVANIA" HAMMER CRUSHERS
IN A BY-PRODUCT COKE PLANT



THE "PENNSYLVANIA" HAMMER CRUSHER is a piece of powerful specialized apparatus for the fine crushing of bituminous coal for by-product coking. "Pennsylvania" Bradford Breakers and Cleaners, crush, clean and size the R.O.M. coal for Hammer Crusher feed.

Two members of the "PENNSYLVANIA LINE" of crushing machinery.

"Bring us your reduction problem."

PENNSYLVANIA
CRUSHER COMPANY



Stephen Girard Building, PHILADELPHIA

NEW YORK
50 Church St.

PITTSBURGH
People's Bank Bldg.

SEATTLE
L. C. Smit